



LOS ANGELES COMMUNITY COLLEGE DISTRICT

CITY / EAST / HARBOR / MISSION / PIERCE / SOUTHWEST / TRADE-TECHNICAL / VALLEY / WEST

DISTRICT SPECIFICATIONS

MAY 2024



BuildLACCD

NOTE:

In the event of conflicting information within the Design Guidelines and Standards the following precedence shall prevail:

1. Volume 2 District Specifications
2. Volume 1 Design Guidelines and Standards
3. Volume 2 Campus Specifications Matrix

Conflicts shall be brought to the attention of the Director of College Facilities (DOCF), Office of Information Technology (OIT), College Project Team (CPT) and District Project Manager (DPM).

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END OF SECTION

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DIVISION 02
EXISTING CONDITIONS

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SECTION 02 41 16
STRUCTURAL DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Demolition, dismantling and cutting of existing building and site improvements as indicated, specified, and necessary for the completion of the Contract.
 - 2. Capping active utilities.
 - 3. Abandoning in-place below-grade construction.
 - 4. Removing inactive utilities.
 - 5. Protective measures.
 - 6. Removing demolished materials from the site.
- B. Related requirements: Site clearing.

1.02 DEFINITIONS

- A. Retain terms that remain after this Section has been edited for a project.
- B. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.
- C. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and [deliver to Owner ready for reuse] [store]. Include fasteners or brackets needed for reattachment elsewhere.

1.03 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and Sequencing:
- B. Pre Installation Meeting: Conduct conference at Project Site.
 - 1. Inspect and discuss condition of construction to be demolished.
 - 2. Review structural load limitations of existing structures.
 - 3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review and finalize protection requirements.
5. Review procedures for [noise control] [and] [dust control].
6. Review procedures for protection of adjacent buildings.
7. Review items to be salvaged and returned to Owner

1.05 SUBMITTALS

- A. Waste management Plan: Provide a Construction and Demolition (C&D) Waste Management Plan and submit to Department of State Architects.
- B. Qualification Data: For refrigerant recovery technician.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property[, for environmental protection] [, for dust control] [and] [, for noise control]. Indicate proposed locations and construction of barriers.
 1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain[including means of egress from those buildings].
- D. Schedule of Building Demolition Activities: Indicate the following:
 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 2. Temporary interruption of utility services.
 3. Shutoff and capping[or re-routing] of utility services.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by salvage and demolition operations. Comply with Section 01 32 33 "Photographic Documentation." Submit before the Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Record documents: At completion of this work, submit record documents showing the actual, dimensioned locations of capped utilities referenced to permanent features surrounding the site.

1.06 QUALITY ASSURANCE

- A. Retain "Refrigerant Recovery Technician Qualifications" Paragraph below if retaining refrigerant removal in Part 3.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

1.07 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
 1. Provide not less than [72] <Insert number> hours' notice of activities that will affect operations of adjacent occupied buildings.

2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
 - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
 - C. Revise first paragraph below if necessary.
 - D. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 1. Before building demolition, Owner will remove the following items:
 - a. <Insert items to be removed by Owner>.
 - E. Retain one of two "Hazardous Materials" paragraphs below, or remove all references to hazardous materials. Insert scope of article to include asbestos, PCBs, and other materials if required. Coordinate statements with the General and Supplementary Conditions. See Evaluations.
 - F. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 1. Hazardous materials will be removed by Owner before start of the Work.
 2. Retain subparagraph below to cover instances where hazardous materials are unexpectedly found and must be remediated. See the General Conditions for additional requirements on hazardous materials.
 3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
 - G. Retain "Hazardous Materials" Paragraph below if hazardous material remediation is part of the Work of this Contract. Consult a professional liability insurance carrier for current recommendations. Indemnification and a waiver of claims may be required from Owner as a condition for providing services related to hazardous material remediation.
 - H. Hazardous Materials: Present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 1. If retaining first subparagraph below, see discussion in Evaluations about Sections dealing with hazardous materials.
 2. Hazardous material remediation is specified elsewhere in the Contract Documents.
 3. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 4. Retain subparagraph below if materials are known to be present. Delete if Owner does not have, or will not provide, material safety data sheets for these materials.
 5. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
 - I. On-site storage or sale of removed items or materials is not permitted.
- 1.08 COORDINATION
- A. Retain this article if demolition will interfere with Owner's operations; insert phasing requirements if applicable.

- B. Arrange demolition schedule so as not to interfere with [Owner's on-site operations] [or] [operations of adjacent occupied buildings].

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

2.02 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Section 31 20 00 Earth Moving.

PART 3 EXECUTION

3.01 GENERAL

- A. Protection: Do not begin demolition until temporary barricades, warning signs and other forms of protection are installed.
 - 1. Protect trees, plants, utilities and existing improvements not to be removed from injury or damage resulting from the Contractor's operation. Replace damaged improvements and utilities in kind at no cost to the Owner.
 - 2. Provide all safeguards, including warning signs and lights, barricades, and the like, for protection of the public, Contractor's employees and adjacent property during demolition.
- B. Noise control: Exercise caution and care to prevent generation of unnecessary noise. Keep noise levels to the minimum possible.
- C. Dust control: Control dust by frequent sprinkling with water or other methods acceptable to the Architect. Assume liability for all claims related to flying dust.
- D. Water control: Control the use of water to prevent damage to the existing facilities and site improvements to remain.
- E. Drainage: Prevent debris from blocking items including, but not limited to, surface drainage inlets and systems, which must remain in operation.

3.02 PREPARATION

- A. Mark location of utilities.
- B. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- C. Shut-off, disconnect, cap-off and seal plumbing, mechanical, and electrical services, in accordance with the requirements of the authorities having jurisdiction, before starting deconstruction. Place markers to indicate location of disconnected services. Identify service lines and capping on record drawings.
- D. Clearly mark location of salvaged material's storage areas, and provide and erect barriers and security devices as required.

3.03 EXISTING CONDITIONS

- A. Intent of Drawings and other reference documents is to show existing conditions with information developed from field surveys and to generally show the extent and type of demolition required.
- B. Make a detailed survey of existing conditions prior to commencing demolition, and report discrepancies or conflicts between Drawings and actual conditions in writing to the Architect for clarifications and instructions.
- C. Do not proceed where such conflicts or discrepancies occur prior to receipt of Architect's instructions.

3.04 DEMOLITION

- A. Perform demolition in a systematic manner. Use such methods as required to complete work in compliance with governing regulations.
- B. Where applicable, such as in public right-of-way, remove existing construction only to the extent indicated or necessary for installation of new construction and junction with existing materials.
- C. Cut back finished surfaces to straight, plumb or level lines as required.

3.05 PATCHING

- A. Patch materials to remain when damaged by demolition at no cost to the Owner.
- B. Finish material and appearance of the patch or repair shall match the existing contiguous materials and finishes in all respects, as approved by the Architect.

3.06 TITLE TO MATERIALS

- A. Except where indicated or specified otherwise, materials and equipment removed shall become the property of the Contractor and shall be removed from the site.
- B. The Owner will not be responsible for the condition or loss of, or damage to, such property after Notice to Proceed.
- C. Material and equipment shall not be viewed by prospective purchasers or sold on the site.

3.07 CLEAN-UP/DISPOSAL

- A. Debris, waste, and removed materials are Contractor's property for legal disposal off the site.
- B. Continuously clean-up and remove these items and do not allow to accumulate on or adjacent to the site. Refer to Section 01 74 00 for additional requirements on this subject.

END OF SECTION

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SECTION 02 41 19

SELECTIVE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Selective demolition, dismantling, cutting and alterations as indicated, specified, and necessary for the completion of the Contract.
2. Rerouting or offsetting existing utilities, such as piping, ducts, conduit and wiring.
3. Removing demolished materials not indicated to be salvaged, from the site.
4. Patching, repairing and finishing existing items to remain to the specified condition with an invisible transition, under normal lighting conditions at the site, between new and existing.
5. Preparation and cleaning of surfaces as required to install new work and finishes.
6. Protection of work to remaining.

B. Related Requirements:

1. Division 01 for special project procedures.
2. Division 01 for temporary building protection.
3. Division 31 for site demolition and clearing.
4. Divisions 22, 23 and 26 for disconnecting, cutting and capping utilities.

C. NIC work: Encapsulation , removal and disposal of asbestos and other hazardous materials.

1.02 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and [deliver to Owner ready for reuse] [store].
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Coordinate definition of "dismantle" with Section 013516 "Alteration Project Procedures" if that Section is also required for Project.
- F. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.03 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and Sequencing:
- B. Pre-demolition meeting:
 - 1. Prior to start of demolition, arrange a meeting between the subcontractor that will be responsible for the work of this Section, the Contractor, the roofing manufacturer's authorized representative, and the Architect to review existing conditions, the Drawings, and the Specifications.
 - 2. Review structural load limitations of existing structure.
 - 3. If more than one trade will be responsible for the successful performance of the work of this Section, these trades shall attend the meeting.
 - 4. Identify areas of concern and remedial measures.
 - 5. Take photographs of the areas of concerns, before and after remedial measures are taken.
 - 6. Review areas where existing construction is to remain and requires protection.
 - 7. Record meeting minutes and distribute copy to all concerned, including the Architect, within 48 hours of the meeting.

1.05 SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property [, for environmental protection] [, for dust control] [and] [, for noise control]. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's [building manager's] [and] [other tenants'] on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 "Photographic Documentation." Submit before Work begins.

- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.
- H. Inventory: Submit a list of items that have been removed and salvaged.

1.06 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.07 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Owner will remove the following items:
 - a. <Insert items to be removed by Owner>.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 - 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- G. Storage or sale of removed items or materials on-site is not permitted.
- H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSP A10.6 and NFPA 241.

2.02 MATERIALS

- A. Contractor's option, except that materials used for patching shall be identical to the existing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. **[Perform]** **[Engage a professional engineer to perform]** an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of **[measured drawings]** **[preconstruction photographs or video]** **[and]** **[templates]**.
 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Protection:
 - 1. Do not begin demolition until temporary partitions, barricades, warning signs and other forms of protection are installed.
 - 2. Protect trees, plants, utilities and existing improvements that are not to be removed from injury or damage resulting from the Contractor's operation. Replace damaged landscaping, improvements and utilities in kind.
 - 3. During demolition provide safeguards, including warning signs and lights, barricades, and the like, for protection of the public, Contractor's employees and existing improvements to remain.
- C. Noise control: Refer to other Sections of Division 01.
 - 1. Exercise caution and care to prevent generation of unnecessary noise.
 - 2. Keep noise levels to the minimum possible.
 - 3. Discontinues noise producing operations, when requested by the Owner, and reschedule at a mutually acceptable time.
- D. Dust control: Control dust at all times.
 - 1. Provide dust-tight partitions to prevent dust escaping into other parts of the building where demolition is not in progress, as specified in other Sections of Division 01.
 - 2. Assume liability for claims related to flying dust caused by this work.
- E. Water control:
 - 1. Control the use of water to prevent damage to the existing facility and improvements to remain. Provide wet vacuum equipment where water, such as waste cooling water from concrete sawing, is used in and adjacent to existing building.
 - 2. Provide impermeable floor coverings and suitable dams to prevent damage by water, and immediately clean-up and remove surplus water, and water spilled in non-working areas.
 - 3. Assume liability for claims related to water seepage and leakage caused by this work.
- F. Security: Coordinate security with the Owner; refer to Section 01 50 00.
 - 1. Take necessary precautions to keep trespassers out of demolition areas.
 - 2. Properly secure demolition areas from entry when demolition is not in progress but do not block required exitways.
- G. Safety:
 - 1. If at any time the safety of existing construction appears to be endangered, take immediate measures to support such endangered construction; cease operations and immediately notify the Architect.
 - 2. Do not resume demolition until Architect's instructions are received.

3.03 SELECTIVE DEMOLITION

- A. Existing conditions:
 - 1. Intent of Drawings is to show existing conditions with information developed from field surveys and to generally show the extent and type of demolition required.

2. Make a detailed survey of existing conditions prior to commencing demolition, and report discrepancies or conflicts between Drawings and actual conditions in writing to the Architect for clarifications and instructions.
 3. Do not proceed where such conflicts or discrepancies occur prior to receipt of Architect's instructions.
- B. The Contractor shall be fully responsible for the adequacy and installation of temporary shoring and bracing systems used during demolition.
- C. Demolition shall be performed by skilled and properly equipped personnel.
- D. Remove existing construction only to the extent necessary for the proper installation of new construction and junction with existing materials. Cut back finished surfaces to straight, plumb or level lines as required.
- E. If unanticipated conditions which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict.
1. Submit report to Architect in written, accurate detail.
 2. Pending receipt of directive from Architect, rearrange demolition schedule as necessary to continue overall job progress without delay.
- F. Where openings are cut oversize or in improper location, replace to excess removed material, to the Architect's satisfaction, at no additional cost to the Owner.
- G. Coordinate demolition with other trades to assure the proper sequence, limits, methods and time of performance. Schedule demolition so as to impose a minimum of hardship on the present operation of the facilities and the performance of the work of other trades.
- H. Whenever possible use small hand or small power tools designed for sawing or grinding; whenever possible avoid the use of tools with a hammering and chopping motion. Cut through finished surfaces from the exposed or finished side into concealed surfaces.
- I. In general remove materials as follows:
1. Portland cement concrete:
 - a. Locate and identify reinforcing bars in concrete prior to drilling and cutting, and protect structural integrity of existing work.
 - b. Use removal methods that will not crack or structurally affect adjacent concrete constructions.
 - c. Cut back concrete to clean, straight lines by saw cutting a minimum of 1 -inch deep; remainder of concrete may be jack-hammered.
 - d. Where indicated and where it will not weaken the structure, cut off reinforcing bars flush with the face of the concrete.
 - e. Where existing reinforcing bars are shown to be bonded into new concrete or masonry, use caution not to bend or otherwise damage them while removing concrete cover. Protect existing rebar from corrosion until new concrete is cast.
 - f. Where new concrete topping or cementitious setting bed will be cast on existing slabs, scarify or scab the surface to a profile of 1/4-inch to provide a mechanical bond with topping or setting bed.
 2. Masonry: Cut back to joint lines and remove old mortar without damaging units to remain to allow space for repairs to backing where applicable.

3. Modular materials:
 - a. Remove to a natural breaking point in whole units to a joint line with no damaged or defective unit remaining where joining new construction.
 - b. After removing flooring materials, clean substrates of old cement and adhesive.
4. Gypsum board: Remove to a joint line on a support.
5. Lath/plaster:
 - a. Saw cut plaster, but not lath and weather barrier (paper backing), cleanly.
 - b. Leave at least 2 -inch of lath exposed to tie into new lath, where applicable.
 - c. Leave sufficient undamaged weather barrier exposed to create a watertight, by proper lapping, joint with the new weather barrier or flashing.
6. Roofing and base flashing: Whenever possible engage the services of the roofer responsible for the installation of the original roofing to retain existing roofing warranty.
 - a. Request the presence of the roofing manufacturer's authorized representative prior to cutting into existing roof.
 - b. Cut-out roof membrane and underlying insulation neatly, with straight, clean edges. Remove only so much roofing and insulation as necessary for new work penetrating the roof membrane.
 - c. After the new work is installed, counterflash the penetrations as indicated and patch the roof membrane with the same membrane as the original roof, lapping a minimum of 6 inches over the existing.
 - d. Obtain the manufacturer representative's approval of the work which must be watertight; conduct water test when required by the manufacturer representative.
7. Utility Services and Mechanical/Electrical Systems:
 - a. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 - b. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1) Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2) Arrange to shut off utilities with utility companies.
 - 3) If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4) Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - (a) Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - (b) Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - (c) Equipment to Be Removed: Disconnect and cap services and remove equipment.

- (d) Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - (e) Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - (f) Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - (g) Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.
- J. Materials not mentioned to be removed that interfere with new construction, except where structural integrity of the assembly is at risk, shall be cut to clean cut lines to provide for proper interface with new construction, or patching and repair, as required.
- K. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

3.04 SALVAGE

- A. Removed and salvaged items: Comply with the following.
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area on-site off-site designated by Owner indicated on Drawings.
 5. Protect items from damage during transport and storage.
 6. See Schedule at the end of the Section for a list of salvage materials.
- B. Title to materials:
1. Except where indicated or specified otherwise, materials and equipment removed and not reused shall become the property of the Contractor and shall be removed from the site.
 2. The Owner will not be responsible for the condition or loss of, or damage to, such property after notice to proceed.
 3. Material and equipment shall not be viewed by prospective purchasers or sold on the site.
- C. Existing items to remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.05 PATCHING

- A. Patch materials to remain when damaged by demolition.
- B. Finish material and appearance of the patch or repair shall match the existing contiguous materials and finishes in all respects, as approved by the Architect.

3.06 CLEAN-UP/DISPOSAL

- A. Debris, waste, and removed materials, other than items to be salvaged, are Contractor's property for legal disposal off the site.
- B. Continuously clean-up and remove these items and do not allow to accumulate in the building and on the site. Refer to Section 01 ** ** for additional requirements on this subject.
- C. Protection of existing work:
 - 1. Install protection before activities within existing building and on existing roof.
 - 2. Activate each fire sprinkler alarm valve system as soon as roof is installed.
 - 3. Protect existing roof from walking, working and equipment with minimum ¾-inch exterior grade plywood.
 - 4. Temporary partitions at interior of existing building: Construct of incombustible materials, with all wood materials fire retardant treated as specified in Section 06105. Dust-proof with tape or other acceptable means. Apply 2 coats of paint to wood surfaces visible to the public and building occupants.
 - 5. Construct partitions indicated of gypsum board or FRT plywood.
 - 6. Other barriers (expected to remain in place less than 45 days) may be built using flame-retardant reinforced polyethylene film.
 - 7. Restore surfaces of existing building to original condition where damaged due to work of this Contract or due to insufficient protection. Pay for repair of damage to contents.
 - 8. Do not allow water to enter wall insulation or roof insulation to remain. Replace when insulation has been wetted.
 - 9. Protect interior of structure from dust and weather and conserve interior heat. Protect temporary openings in exterior walls with fire-retardant treated weatherproof plywood or reinforced polyethylene barriers.

3.07 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: <Insert description of items and construction to remove>.
- B. Remove and Salvage: <Insert description of items to remove and salvage>.
- C. Remove and Reinstall: <Insert description of items to remove and reinstall>.
- D. Existing to Remain: <Insert description of items to remain>.
- E. Dismantle: <Insert description of items to be removed>.

END OF SECTION

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DIVISION 03

CONCRETE

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SECTION 03 10 00
CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Formwork for cast-in-place concrete as indicated.
 - 2. Installation of items to be embedded in concrete, such as anchor bolts, inserts, embeds, and sleeves.
- C. Related Sections:
 - 1. Section 01420: Testing and Inspection.
 - 2. Section 03200: Concrete Reinforcement.
 - 3. Section 03300: Cast-In-Place Concrete.

1.02 REFERENCES

- A. American Concrete Institute (ACI) Publication:
 - 1. ACI 318 – Building Code Requirements for Structural Concrete, Chapter 6, Formwork, Embedded Pipes, and Construction Joints.
 - 2. ACI 347 – Guide to Formwork for Concrete.
- B. American Plywood Association (APA):
 - 1. Form No. V345 - Concrete Forming Design/Construction Guide.
- C. National Institute of Standards and Technology (NIST):
 - 1. NIST Voluntary Product Standard PS 1.

1.03 SUBMITTALS

- A. Submit detailed structural calculations and drawings approved and signed by a California registered Civil Engineer where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or where provision for vehicular traffic through falsework or shoring occurs. For all other falsework and shoring submit layout signed by California registered Civil Engineer, manufacturer's authorized representative or a licensed contractor experienced in the usage and erection of falsework and vertical shoring. A copy of the plans and calculation shall be available at the jobsite at all times.
- B. Shop Drawings: Submit Shop Drawings indicating locations of forms, construction and expansion joints, embedded items, and accessories. Review and approval will not include form strength and adequacy.

- C. Product Data: Submit manufacturer's Product Data for form materials and accessories.
- D. Record Document: Keep an accurate record of the dates of removal of forms, form shores and reshores, and furnish copies to the Architect.

1.04 REGULATORY REQUIREMENTS

- A. California Building Code (CBC), Chapter 19A, and ACI 318.
- B. California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 4, Construction Safety Orders, Article 6, Excavations, Sections 1713 and 1717.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Storage shall prevent damage and permit access to materials for inspection and identification.
- B. Deliver materials for forms in timely manner to ensure uninterrupted progress.

1.06 QUALITY ASSURANCE

- A. Construction of Forms shall comply with the following as a minimum requirement:
 - 1. ACI 347, "Recommended Practice for Concrete Formwork"
 - 2. ACI 318 Section 26.11 and CBC Section 1905A.
 - 3. Tolerances shall conform to those as specified in ACI 301, "Specifications for Structural Concrete for Buildings", as applicable, unless exceeded by requirements of DSA or otherwise indicated or specified.
 - 4. Plywood: Conform to tables for form design and strength in APA Form V 345.
- B. Prior to construction of formwork for concrete beams and slabs above grade, Contractor shall conduct a meeting at the site to determine and define all camber, which may be required for the project. The Architect, Structural Engineer of record, Contractor and Contractor's formwork installer shall be in attendance at this meeting.
- C. Mock-ups: Provide mock-ups for exposed finishes if required by the Architect; 100 square feet minimum size. Locate as required by the Architect, for review and approval prior to installation. This applies to the exposed surface of retaining walls for this project.

PART 2 PRODUCTS

2.01 GENERAL

- A. Form materials may be reused during progress of the Work provided they are completely cleaned and reconditioned, recoated for each use, capable of producing formwork of required quality, and are structurally sound.
- B. Form Lumber: WCLIB Construction Grade or Better, WWPA No. 1 or Better.
- C. Plywood: NIST Voluntary Product Standard PS 1, Group 1, Exterior Grade B-B Plyform or better, minimum 5-ply and 3/4 inch thick for exposed locations and at least 5/8 inch thick for unexposed locations, grade marked, not mill oiled. Furnished plywood with medium or high density overlay is permitted.

- D. Coated Form Plywood: For exposed painted concrete, plastic overlaid plywood of grade specified above, factory coated with a form coating and release agent "Nox-crete", or equal.
- E. Tube Forms: Sonoco "Seamless Sonotubes," or equal, of the type leaving no marks in concrete, one-piece lengths for required heights.
- F. Joist Forms: Code recognized steel or molded plastic types as required.
- G. Special Forms: For exposed integrally-colored concrete, plywood as above with high density overlay, plywood with integral structural hardboard facing or fibrous glass reinforced plastic facing, providing specified finish.
- H. For Exposed Concrete Finish:
 - 1. Plywood: New, waterproof, synthetic resin bonded, exterior type Douglas fir or Southern pine plywood manufactured especially for concrete formwork and conforming to NIST Voluntary Product Standard PS 1, Grade B-B grade, Class I.
 - 2. Glass-Fiber-Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surfaces.
 - 3. Steel: Minimum 16 gage sheet, well matched, tight fitting, stiffened to support weight of concrete, without deflection detrimental to tolerances and appearances of finished concrete surfaces.
 - 4. Plywood: "Finland Form," or "Combi Form" distributed by North American Plywood Corporation or equal. The material shall be furnished with hard smooth birch face veneers with phenolic resin thermally fused onto panel sides. Edges shall be factory sealed.
- I. Form Ties: Prefabricated rod, flat band, wire, internally threaded disconnecting type, not leaving metal within 1-1/2 inch of concrete surface.
- J. Form Coating: Non-staining clear coating free from oil, silicone, wax, not grain-raising, conforming to ASTM C309. Where form liners are furnished, provide form coatings recommended by form liner manufacturer.
- K. Form Liner: Rigid or resilient type by L.M. Scofield, Symons, Greenstreak or equal, types shown or directed, matching approved Sample.
- L. Void Forms: Manufactured by SureVoid Products, Inc., or equal. Forms shall be "WallVoid" for temporary support of concrete walls and grade beams spanning between supports, and "SlabVoid" for creating gaps between concrete slabs or steps and underlying soils. Void forms shall be fabricated of corrugated paper with moisture resistant exterior, and shall be capable of withstanding working load of 1,500 psf. Provide accessories as required.

PART 3 - EXECUTION

3.01 GENERAL

- A. Forms shall be constructed so as to shape final concrete structure conforming to shape, lines and dimensions of members required by Drawings and Specifications, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together to maintain position and shape with no sagging, displacement, or bulging between studs. Forms and their supports shall be designed so that previously placed structures will not be damaged. Use clean, sound, approved form material, coated with specified materials only, not oil. Provide backing on all plywood joints. Forms shall be true to line within tolerances as permitted under section 1.6 above.

3.02 TOLERANCES

- A. Permitted abrupt or gradual irregularities in formed surfaces as measured within a 5 feet length with a straightedge shall per ACI 347, Table 5.3.1:

Class of Surface			
A	B	C	D
1/8 inch	1/4 inch	1/2 inch	1 inch

1. Class A: Use for concrete surfaces prominently exposed to public view.
 2. Class B: Use for coarse-textured concrete-formed surfaces intended to receive plaster, stucco or wainscoting.
 3. Class C: Use as a general standard for permanently exposed surfaces where other finishes are not specified.
 4. Class D: Use for surfaces where roughness is not objectionable and will be permanently concealed.
- B. Finish Lines: Position formwork to maintain hardened concrete finish lines within following permissible deviations.
1. Variation from Plumb:

a.	In 10'-0"	1/4 inch
b.	In any story or 20'-0"	3/8 inch
c.	In 40'-0" or more	3/4 inch
 2. Variation from Level or Grades Indicated:

a.	In 10'-0"	1/4 inch
b.	In any bay or 20'-0" maximum	3/8 inch
c.	In 40'-0" or more	3/4 inch
 3. Cross-Sectional Dimensions:

a.	Minus	1/4 inch
b.	Plus	1/2 inch
 4. Building Lines: Variation of linear building lines from established position in plan and related position of columns, walls and partitions:

- a. In any bay or 10'-0" maximum 1/2 inch
- b. In 40'-0" or more 1 inch

C. Slab Openings: Variations in size and location of sleeves and slab openings shall not exceed 1/4 inch.

3.03 ERECTION

- A. Conform to ACI 301 and ACI 347 except as exceeded by the requirements of code, regulatory agencies, or herein.
- B. Plywood shall be installed with horizontal joints level, vertical joints plumb and with joints tight. Back joints by studs or solid blocking, and fill where necessary for smoothness. Reused plywood shall be thoroughly cleaned, damaged edges or surfaces repaired and both sides and edges oiled with colorless form oil. Nail plywood along edges, and to intermediate supports, with common wire nails spaced as necessary to maintain alignment and prevent warping.
- C. Construction: Coat forms with the specified resin coating, not form oil. Construct forms to exact shapes, sizes, lines, and dimensions required to obtain level, plumb, and straight surfaces. Provide openings, offsets, keys, reglets, anchorages, recesses, moldings, chamfers, blocking, screeds, drips, bulkheads, and all other required features. Make forms easily removable without hammering or prying against concrete. Space forms apart with metal spreaders. Construct forms to accurate alignment, location and grades, and provide against sagging, leakage of concrete mortar, or displacement occurring during and after placing of concrete. Coordinate installation of inserts and anchors in forms according to Shop Drawings and requirements for work of other sections.
- D. Openings for Cleaning: Provide temporary openings at points in formwork to facilitate cleaning and inspection. At base of walls and wide piers, bottom form board on one face for entire length shall be omitted until form has been cleaned and inspected.
- E. Chamfers: Provide 3/4 inch by 3/4 inch chamfer strips for all exposed concrete corners and edges unless otherwise indicated.
- F. Reglets and Rebates: As specified in Section 03 3000: Cast-In-Place Concrete. Form required reglets and rebates to receive frames, flashing, and other equipment if required by Architect.
- G. Form Joints: Fill joints to produce smooth surfaces, intersections, and arises. Use polymer foam or equivalent fillers at joints and where forms abut or overlap existing concrete to prevent leakage of mortar.
- H. Recesses, Drips, and Profiles: Provide smooth milled wood or pre-formed rubber or plastic shapes of types shown and required.
- I. Re-Use: Clean and recondition form material before re-use.

3.04 REMOVAL OF FORMS

- A. Forms shall not be removed until concrete has sufficiently hydrated to maintain its integrity and not be damaged by form removal operations. Unless noted otherwise and/or permitted by the Architect, columns and wall forms shall not be removed in less than 24 hours, floor slabs in less than 7 days, beams and girders in less than 15 days, pan forms for joists may be removed after 3 days, but joist centering shall not be removed until after 15 days, and ramp, landing, steps and floor slabs shall not be removed in less than 7 days. Shoring shall not be removed until member has acquired sufficient strength to support its weight, load upon it, and added load of construction. In no case shall forms be removed sooner than specified in ACI 347, Table 5.7.2.3, or ACI 318 Section 26.11.
- B. Compressive strength of in-place concrete shall be determined by testing field-cured specimens representative of concrete location or members, as specified in Section 03 3000: Cast-In-Place Concrete.
- C. Avoid damage to concrete surfaces during form removal.
- D. Store reusable forms for exposed architectural concrete to prevent damage to contact surfaces.
- E. Remove formwork in same sequence as concrete placement to achieve similar concrete surface coloration.

3.05 SURVEY AND ADJUSTMENT:

- A. Check forms before and during placement of concrete, using an instrument, and make corrections as work proceeds.

3.06 EMBEDDED PIPING AND ROUGH HARDWARE:

- A. Comply with ACI 318, Section 26.8. Where work of other sections require openings for passage of pipes, conduits, ducts, and other inserts in the concrete, obtain all dimensions and other information. All necessary pipe sleeves, anchors, or other required inserts shall be accurately installed as part of the work of other sections, according to following requirements.
- B. Conduits or Pipes
 1. No pipe/conduit runs shall be embedded in structural concrete unless indicated on the structural drawings.
 2. Where pipe/conduit is indicated, it shall conform to the following requirements:
 - a. Conduits/pipes of aluminum shall not be embedded in structural concrete unless coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and reinforcing steel.
 - b. Conduits/pipes shall be located so as not to reduce strength of concrete. In no case place conduit/pipes in a slab 8" thick or less. Conduit buried in a concrete slab shall not have an outside diameter greater than 1/3 the slab thickness nor be placed below the bottom reinforcing steel or over top reinforcing steel. Embedded conduit/pipes shall be approved by the engineer of record prior to concrete placement.
- C. Sleeves: Pipe sleeves may pass through slabs or walls if not exposed to rusting or other deterioration and are of uncoated or galvanized iron or steel. Provide sleeves of diameter large enough to pass any hub or coupling on pipe, including any insulation.

3.07 FIELD QUALITY CONTROL

- A. Inspection: Obtain inspection and approval of forms before placing structural concrete.

3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.09 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

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SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Reinforcing bars for cast-in-place concrete
 - 2. Reinforcing mesh for cast-in-place concrete
 - 3. Accessories, including but not limited to chairs and tie wires
 - 4. Reinforcing bars for masonry
 - 5. Reinforcing bars for site-cast pre-cast concrete
 - 6. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, and other items as shown or required to complete all work.
- C. Related Sections:
 - 1. Section 01 4100: Testing and Inspection.
 - 2. Section 03 1000: Concrete Formwork.
 - 3. Section 03 3000: Cast-In-Place Concrete.

1.02 SYSTEM DESCRIPTION

- A. Regulatory Requirements: Fabrication and placement of reinforcing shall be in accordance with requirements of CBC, Chapter 19A and ACI 318.

1.03 REFERENCES:

- A. Comply with the following as a minimum requirement:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - c. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - d. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - e. ASTM A497 - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

- f. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - g. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
2. American Concrete Institute (ACI) Publication:
 - a. ACI 315 – Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - b. ACI 318 – Building Code Requirements for Structural Concrete, as modified by CBC Sections 1905A.
 - c. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
 3. American Welding Society (AWS):
 - a. AWS D1.4 – Structural Welding Code – Reinforcing Steel.
 4. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.
 5. California Building Code, Chapter 19A, Concrete.

1.04 SUBMITTALS

- A. Shop Drawings: Submit steel reinforcement Shop Drawings in accordance with ACI 315. Shop drawings should include complete layouts, sections, and details for congested conditions, typical bending diagrams and offsets, splice lengths and locations, proposed layout where vertical and horizontal bars intersect, and wherever welding is proposed, detailed to conform to AWS and CBC requirements. Include slab plans, size and lengths of reinforcing steel.
- B. Certification: Submit copies of welding operator's certificate.
- C. Chemical Analysis: Provide for bars to be welded, in accordance with ACI 318 Section 26.6.4.
- D. Closeout Submittals: Record locations and quantities of reinforcing that vary from Shop Drawings.
- E. LEED Documentation: Submit the following documentation
 1. Specific product name, make, model, and manufacturer
 2. Material Cost
 3. Environmental Product Declaration (EPD) report:
 - a. Product-specific declaration: Manufacturer's Life Cycle Assessment conforming to ISO 14044
 - b. Product Specific Type III EPD with third-party Type III certification
 - c. Industry-wide (generic) EPD with third-party Type III certification
 4. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.

1.05 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement:
 1. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.

2. American Welding Society (AWS).
 3. American Concrete Institute (ACI).
 4. CBC, Chapter 19A, Concrete.
- B. Source Quality Control: Refer to Division 01 Sections, CBC Chapters 17A and 19A, and ACI 318 Chapter 26 for general requirements and to the following paragraphs for specific procedures. Testing laboratory retained by the Owner shall select test Samples of bars, ties, and stirrups from the material at the Project Site or from the place of distribution, with each Sample consisting of not less than two 18 inch long pieces, and perform the following tests according to ASTM A615, or ASTM A706, as applicable:
1. Identified Bars: If Samples are obtained from bundles as delivered from the mill, identified as to heat number, accompanied by mill analyses and mill test reports, and properly tagged with the identification certificate so as to be readily identified, perform one tensile and one bend test for each 10 tons or fraction thereof of each size of bars. Submit mill reports when Samples are selected.
 2. Unidentified Bars: When positive identification of reinforcing bars cannot be performed and when random Samples are obtained, perform tests for each 2.5 tons or fraction thereof, one tensile and one bend test from each size of bars.
 3. Testing to be per CBC Sections 1910A and 1704A.
- C. Certification of Welders: Shop and Project site welding shall be performed by welding operators certified by AWS.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Avoid exposure to dirt, moisture or conditions harmful to reinforcing.
- B. Reinforcing steel bars, wire, and wire fabric shall be stored on the Project site to permit easy access for examination and identification of each shipment. Material of each shipment shall be separated for size and shape. Use metal tags indicating size, length and other marking shown on placement drawings. Maintain tags after bundles are broken.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide reinforcing of sizes, gages and lengths indicated, bent to indicated shapes.

2.02 MATERIALS

- A. Steel Reinforcing Bars: ASTM A615, or ASTM A706 deformed grade 60 billet steel unless otherwise specified or indicated. Deformations to be per ASTM A-305.
- B. Reinforcing Bars for welding: ASTM A706, Grade 60.
- C. Welded Wire Fabric for Reinforcement: ASTM A185, 60 KSI minimum tensile strength.
- D. Tie Wire: ASTM A82, fully annealed, copper-bearing steel wire, 16 gage minimum.

- E. Chairs, Spacers, Supports, and Other Accessories: Standard manufacture conforming to CRSI and ACI 315 fabricated from steel wire of required types and sizes. For reinforcement supported from grade, provide properly sized dense precast blocks of concrete with embedded wire ties.
- F. Welding electrodes: AWS D1.4, Table 5.1 and 5.3 low hydrogen electrodes, E9018 for Grade 60 steel.

2.03 FABRICATION OF REINFORCING BARS:

- A. Comply with CRSI Manual of Standard Practice for Reinforced Concrete Construction for fabrication of reinforcing steel.
- B. Bending and Forming: Fabricate bars of the indicated sizes and bend and form to required shapes and lengths by methods not injurious to materials. Do not heat reinforcement for bending. Bend bars No. 6 size and larger in the shop only. Bars with unscheduled kinks or bends are not permitted. Provide only tested and permitted bar materials.
- C. Welding: Provide only ASTM A706 steel where welding is indicated. Perform welding by the direct electric arc process in accordance with AWS D1.4 and specified low-hydrogen electrodes. Preheat 6 inches each side of joint. Protect joints from drafts during the cooling process; accelerated cooling is not permitted. Do not tack weld bars. Clean metal surfaces to be welded of loose scale and foreign material. Clean welds each time electrode is changed and chip burned edges before placing welds. When wire brushed, the completed welds must exhibit uniform section, smooth welded metal, feather edges without undercuts or overlays, freedom from porosity and clinkers, and good fusion and penetration into the base metal. Cut out welds or parts of welds deemed defective, using chisel, and replace with proper welding. Prequalification of welds shall be in accordance with CBC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as indicated on reviewed Shop Drawings. Before installation, and again before concrete is placed, clean reinforcing of loose scale, rust, oil, dirt and any coating that could reduce bond.
- B. Securing in Place: Accurately place bars and wire tie in precise position where bars cross. Bend ends of wire ties away from the forms. Wire tie bars to corners of ties and stirrups. Support bars according to the current edition of "Recommended Practice for Placing Bar Supports" of Concrete Reinforcing Steel Institute, using approved accessories and chairs. Place precast concrete cubes with embedded wire ties to support reinforcing steel bars in concrete placed on grade and in footings. Use care not to damage vapor barriers where they occur. Accurately position, install, and secure reinforcing to prevent displacement during the placement of concrete.
- C. Exposed Concrete Surfaces: Provide stainless steel or exterior quality vinyl plastic tipped chairs, bolsters, and accessories where exposed on exterior or interior concrete surfaces not to be painted or permanently covered. Provide metal chairs to hold reinforcement the required distance above form bottoms. In beams and slab construction, provide chairs under top slab reinforcement as well as under bottom reinforcement. Space chairs so that reinforcement will not be displaced during installation. Provide metal spacers to secure proper spacing. Stirrups shall be accurately and securely wired to bars at both top and bottom. At slabs, footings, and beams in contact with earth, provide concrete blocks to support reinforcement at required distance above grade.

- D. Clearances: Maintain minimum clear distances between reinforcing bars and face of concrete as indicated on Structural Drawings.
- E. Splices: Do not splice reinforcing bars at the points of maximum stress except where indicated. Lap splices as shown or required to develop the full strength or stress of bars. Stagger splices in horizontal wall bars at least 48" longitudinally in alternate bars and opposite faces.
- F. Field Welding of Bars: As specified on plans for fabrication. All welding to be per ACI 318 Section 26.6.4.
- G. Maintaining Bars In Position: Take adequate precautions to assure that reinforcing position and spacing is maintained during placement of concrete.
- H. Reinforcing Mesh: Lap one full mesh plus 2", or 9" whichever is greater, at splices, wire tie, and support the same as specified for bars.
- I. Do not install reinforcing in supported slabs and beams until walls and columns have been installed to underside of slabs and beams or until construction joints have been thoroughly cleaned. Reinforcing shall be inspected before placement of concrete and cleaned as required.
- J. Use deformed bars unless otherwise indicated.
- K. Splice Devices:
 - 1. Type and manufacturer as noted on drawings. If substitution is requested, contractor to supply manufacturer calculations and supporting data showing proposed substitution conforms to requirements indicated and supplied.
 - 2. Install in accordance with manufacturer's written instructions.
 - 3. Splices shall develop at least 125% of the yielding strength of the bar.

3.02 FIELD QUALITY CONTROL:

- A. Supervision: Perform Work to this Section under supervision of a capable superintendent.
- B. Inspection: Obtain inspection per CBC Sections 1704A.4.2 & 1903A and approval of reinforcing before concrete is placed.
- C. Welding Inspection: Whether welding is done in the shop or at the site, perform welding of reinforcing bars under inspection of the Testing Laboratory Welding Inspector who is specially qualified and approved by DSA in accordance with CBC Section 1704A.4.2. The welding inspector shall make a systematic record of all welds.
 - 1. This record shall include:
 - a. Identification marks of welders.
 - b. List of defective welds.
 - c. Manner of correction of defects.

2. The welding inspector shall check the material, equipment details of construction, and procedures as well as the welds. The inspector shall also check the ability of the welder. The welder shall furnish the architect, structural engineer and the enforcement agency with a verified report that the welding which is required to be inspected is proper and has been done in conformity with the approved plans and specifications. The welding inspector shall use all means necessary to determine the quality of the weld. The inspector may use gamma ray, magnaflux, trepanning, sonics or any other aid to visual inspection, which the inspector may deem necessary to assure the adequacy of the welding.

3.03 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Cast-in-place normal weight and lightweight concrete, placement and finishing.
- A. Related Sections:
 - 1. Section 01 41 00: Testing and Inspection
 - 2. Section 03 10 00: Concrete Forms and Accessories.
 - 3. Section 03 20 00: Concrete Reinforcement.

1.02 REFERENCES

- A. Comply with the following American Concrete Institute (ACI) Publications as a minimum requirement:
 - 1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211 – Recommended Practice for Selecting Proportions of Concrete. ACI 301 – Specifications for Structural Concrete.
 - 3. ACI 302.1R – Guide for Concrete Floor and Slab Construction.
 - 4. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - 5. ACI 305.1 - Specification for Hot Weather Concreting.
 - 6. ACI 306.1 – Standard Specification for Cold Weather Concreting.
 - 7. ACI 308 – Recommended Practice for Curing Concrete
 - 8. ACI 309 – Recommended Practice for Consolidation of Concrete
 - 9. ACI 318 - Building Code Requirements for Structural Concrete, as modified by CBC Section 1905A.
- B. Comply with the following American Society for Testing and Materials (ASTM) Standards as a minimum requirement:
 - 1. ASTM C31 – Standard Specification for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C88 - Standard Test Method for Soundness of Aggregates by use of Sodium Sulphate or Magnesium Sulphate.
6. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
7. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
8. ASTM C150 – Standard Specification for Portland Cement
9. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
10. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
11. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C227 – Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
13. ASTM C231 – Air Content of Freshly Mixed Concrete by the Pressure Method.
14. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
15. ASTM C289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
16. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
17. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
18. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
19. ASTM C567 - Standard Test Method for Determining Density of Structural Lightweight Concrete.
20. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
21. ASTM C845 - Standard Specification for Expansive Hydraulic Cement
22. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
23. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
24. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
25. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
26. ASTM C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
27. ASTM D1751 - Standard Test Method for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
28. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
29. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

30. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
31. ASTM E1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.03 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating locations of cast-in-place concrete work, dimensioned locations and types of construction and expansion joints, and accessory items such as vapor barriers. Include details and locations of reinforcing, embedded items, and interfacing with other Work.
- B. Mix Design Data: Submit concrete mix designs as specified herein and in Article 2.2.
 1. Submit name, address and telephone number of the concrete production facility which the contractor intends to engage to design the concrete mixes. Submit name and qualifications of the proposed concrete technologist.
 2. Mix Design: Submit a concrete mix design for each strength and type of concrete indicated in the drawings or specified. Include water/cement ratio, source, size and amount of coarse aggregate and admixtures. Predict minimum compressive strength, maximum slump and air content percentage. Clearly indicate locations where each mix design will be used. Limit water content per cubic yard of mixed concrete to: 300 pounds maximum for normal weight concrete (pea gravel mixes exempt), 325 pounds maximum for light weight concrete.
 3. Test Reports: Submit copies of test reports showing that the proposed mixes produce concrete with the strengths and properties specified. Include tests for cement, aggregates and admixtures. Provide gradation analysis.
- C. Material Samples: Contractor to provide 3' x 3' mock-up samples for each type of concrete color, finish and jointing for Owner's approval prior to installation where the formed surface will be permanently exposed as a finish (seating wall, slab on grade, lightweight concrete over metal decking).
- D. Certificates: Submit notarized certification that each of the following conforms to the standards indicated:
Portland cement: ASTM C150.
Normal weight concrete aggregates: ASTM C33.
Lightweight concrete aggregates: ASTM C330.
 1. Aggregates: Submit evidence that the aggregate is not reactive in the presence of cement alkalis. In the absence of evidence, aggregate shall be tested per ASTM C289. If results of test are other than innocuous, aggregates shall be tested per ASTM C1567, see CBC Section 1903A.5.
 2. Curing materials: ASTM C171.
 3. Manufacturer of ready-mixed concrete shall deliver to the IOR a certificate with each mixer truck. Certificate shall bear the signature of representative of the testing laboratory, and shall state quantity of cement, water, fine and coarse aggregate and admixtures.
 4. Admixtures: ASTM C260.
- E. Admixtures: Submit product data for proposed concrete admixtures.

- F. LEED Documentation: Submit the following documentation
1. Specific product name, make, model, and manufacturer
 2. Material Cost
 3. Environmental Product Declaration (EPD) report:
 4. Industry-wide (generic) EPD with third-party Type III certification
 5. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.
 6. Extracted, Manufactured, and Purchased locally. Provide cutsheets, product literature or letter from the manufacturer indicating the location of extraction, manufacturing, and purchasing and distance from the project site.

1.04 QUALITY ASSURANCE

- A. Concrete Manufacturer: Furnish concrete from licensed commercial ready-mix concrete plant conforming to DSA approved plans as well as CBC Chapter 19A and ACI 318-14 as modified by CBC section 1905A.
- B. Continuous inspection shall be provided at the batch plant and for transit-mixed concrete to run check sieve analysis of aggregate, check moisture content of fine aggregate, check design of mix, check cement being used with test reports, check loading of mixer trucks, and certify to quantities of materials placed in each mixer truck.
- C. Inspection shall be performed by a representative of a testing laboratory selected by the Owner. Owner will pay for inspection costs. Notify the laboratory 24 hours in advance of time concrete is to be mixed. Notify the laboratory of postponement or cancellation of mixing within at least 24 hours of scheduling time.
- D. Contractor shall assist the testing laboratory in obtaining and handling samples at the project site and at the source of materials.
- E. Continuous batch plant inspection requirement may be waived in accordance with CBC Section 1705A.3.3. Waiver shall be in writing, including DSA approval. When batch plant inspection is waived by DSA, the following requirements shall be met:
1. Approved inspector of the testing laboratory shall check the first batching each day for each approved mix design and furnish mix proportions to the licensed weightmaster.
 2. Licensed weightmaster shall positively identify materials as to quantity and certify to each load by a ticket.
 3. Tickets shall be transmitted to the IOR by a truck driver with load identified thereon. The IOR will not accept the load without a load ticket identifying the mix and will keep a daily record of placements, identifying each truck, its load and time of receipt and approximate location of deposit in the structure and will transmit a copy of the daily record to DSA.
 4. At the end of the project, the weightmaster shall furnish an affidavit to DSA certifying that all concrete furnished conforms in every particular to proportions established by mix designs.
- F. Special Inspections and Tests shall be in accordance with CBC Chapter 17A, CBC Section 1910A and Specification Section 01 4100.

- G. Allowable Tolerances: Construct concrete conforming to the tolerances specified in ACI 117 "Recommended Tolerances for Concrete Construction and Materials", as applicable, unless exceeded by requirements of regulatory agencies or otherwise indicated or specified.
- H. Source Quality Control: Refer to the following paragraphs for specific procedures. Concrete materials which, by previous tests or actual service, have shown conformance may be used without testing when so approved by the Architect and DSA. Testing Laboratory shall perform following conformance testing.
1. Cement: Furnish mill certificates in accordance with the CBC section 1910A.1 and acceptable to Architect and DSA, showing conformance with requirements specified.
 2. Cementitious Material Test. The concrete supplier shall furnish to the enforcement agency certification from the cement manufacturer that the cement proposed for use on the project has been manufactured and tested in compliance with the requirements of ASTM C 150 for Portland cement and ASTM C 595 or ASTM C 1157 for blended hydraulic cement, whichever is applicable. When a mineral admixture or ground granulated blast-furnace slag is proposed for use, the concrete supplier shall furnish to the enforcement agency certification from the manufacturer that they have been manufactured and tested in compliance with ASTM C 618 or ASTM C 989, whichever is applicable. The concrete producer shall provide copies of the cementitious material supplier's certificate of compliance that represents the materials used by date of shipment for concrete. Cementitious materials without certification of compliance shall not be used per section 1910A.1 of the CBC.
 3. Aggregates for Normal Weight Concrete: Test the aggregate before and after concrete mix is designed and whenever character of aggregate varies or source of material is changed in accordance with ASTM C33 and CBC section 1903A.5. Include a sieve analysis. Obtain samples of aggregates at the dry batching or ready-mix concrete plant in accordance with ASTM D75 and perform tests for the properties listed in the following table.
 4. Aggregates for Lightweight Concrete: Test the lightweight aggregates before mix is designed and whenever the character of aggregate varies or source is changed in accordance ASTM C330. Include sieve analyses, report on unit weights, report on deleterious substances, unburned or under-burned lumps, loss on ignition, soundness, staining materials, and crushed particles in coarse aggregate. Splitting tensile strength (FSP); 5.5 minimum

PHYSICAL PROPERTIES		
Physical Properties, units	Test Method	Minimum values
Sieve analysis	ASTM C136	
Organic impurities	ASTM C40	Fine aggregate not darker than reference standard color
Soundness	ASTM C88	Loss after 5 cycles not more than 8 percent of coarse aggregate, nor more than 10 percent of fine aggregate
Abrasion	ASTM C131	Weight loss not more than 10.5 percent after 100 revolutions, 42 percent after 500 revolutions
Deleterious materials	ASTM C33	
Materials finer than No. 200 sieve	ASTM C117	Not over 1 percent for gravel, 1.5 percent for crushed aggregate

Reactivity potential	ASTM C227, C289, C342	Ratio of silica released to reduction in alkalinity not to exceed 1.0.
Sand equivalent	ASTM D2419	California sand equivalent values operating range not below 71 percent

- I. Compliance with Regulations: All materials shall comply with the current rules and regulations of the local air quality management district, with the rules regarding volatile organic compounds, and with FDA rules and regulations for dangerous substances in construction products.

1.05 CONCRETE MIX DESIGNS

- A. A registered civil engineer with experience in concrete mix design shall select the relative amounts of ingredients to be used as basic proportions of the concrete mixes proposed for use under the provisions of ACI 318 Section 26.4. Mixes shall be based on existing approved compressive strength test data for concrete mixes in accordance with ACI 301 and requirements below:
- B. Strength Requirements: Design mixes for structural concrete for minimum 28-day compressive strengths required by Drawings and Specifications. The trial batch strength for each mix shall exceed indicated or specified strength by 750 psi or a lesser amount based on the standard deviations of strength test records according to ACI 318.
- C. Normal Weight Concrete Mix Design: Design all mixes for workability and durability of concrete. Control the mixes in accordance with ACI 301 and Section 26.4 of ACI 318, Building Code Requirements for Reinforced Concrete. Make adjustments in cement content required for concrete strengths at Contractor's expense and do not exceed 0.60 (or as indicated on concrete general notes of approved plans) absolute water-cement or cement plus fly ash ratio by weight. Do not use calcium chloride or any admix containing such material. Admixtures containing a material releasing nitrates in solution are limited to 0.06 percent by weight for the chloride ion.
- D. Maximum Aggregate Sizes: Not exceeding 3/4 of minimum clear space between bars and between bars and forms, nor larger than 1/5 of least dimensions between the forms.
- E. Design the mixes with 1" maximum size, except maximum 1-1/2" size for foundations and maximum 3/8" size at congested reinforcing or thin sections, as submitted by the contractor and approved by the Architect and Structural Engineer of Record.
- F. ACI 301 with test records. Where a testing laboratory acceptable to the enforcement agency has records of compressive strength tests, a standard deviation shall be established. Test records from which a standard deviation is calculated shall:
1. Represent materials, quality control procedures and conditions similar to those expected, and changes in materials and proportions within the test records shall not have been more restricted than those for proposed work.
 2. Represent concrete produced to meet a specified strength or strengths $f'c$ within 1,000 psi of that specified for proposed work.
 3. Must consist of at least 30 consecutive tests or two groups of consecutive tests totaling at least 30 tests as defined in ACI 301.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store cement and aggregate materials so as to prevent their deterioration or intrusion by foreign matter. Deteriorated or contaminated materials shall not be furnished.

- B. Packaged materials shall bear the manufacturers and brand name label, and shall be stored in their original unbroken package in a weather tight place until ready for use in the work.
- C. Ready-mix concrete shall be mixed and delivered in accordance with ASTM C 94. Each batch of concrete delivered to the Project site shall be accompanied by a time slip bearing departure time and signature of batch plant supervisor. Concrete shall be placed within 90 minutes after start of mixing. Deliver all materials in timely manner to ensure uninterrupted progress of the work.

1.07 PROJECT CONDITIONS

- A. Cold Weather Requirements: Batching, mixing, delivering and placing of concrete in cold weather shall comply with the applicable requirements of ACI 306.1. When placing concrete during freezing or near-freezing weather the mix shall have a temperature of at least 50 degrees F, but not more than 90 degrees F when cement is added. Concrete shall be maintained at a temperature of at least 50 degrees F. for at least 72 hours after placing or until it has thoroughly hydrated. When necessary, concrete materials shall be heated before mixing. Special precautions shall be provided for protection of transit-mixed concrete. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. Surfaces, in which concrete is to come in contact with, shall be free from frost or ice. No frozen materials or materials containing ice shall be furnished.
- B. Hot Weather Requirements: Batching, mixing, delivering and placing of concrete in hot weather shall comply with the applicable requirements of ACI 305R. During hot weather, proper attention shall be provided for ingredients, production methods, handling, placing, protection and curing, to prevent excessive concrete temperatures or water evaporation which could impair required strength or durability.
- C. Concrete temperature of freshly mixed concrete shall be determined per ASTM C1064.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: ASTM C150. Portland Cement or ASTM C595 for Blended Hydraulic Cement.
- B. Aggregates: Conform to the following standards:
 - 1. Normal weight concrete: ASTM C33
 - 2. Aggregate shall be tested for Potential Alkali Reactivity of Cement-Aggregate Combinations per ASTM C289.
 - 3. Nominal maximum size of coarse aggregate shall be no larger than:
 - a. 1/5 the narrowest dimension between sides of forms, nor
 - b. 1/3 the depth of slabs, nor
 - c. 3/4 the clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, or ducts.
 - 4. Aggregates shall be from approved pits, free from vegetable matter and of opaline, feldspar, or siliceous magnesium substances; all washed, clean, hard, fine-grained sound crushed rock or gravel; not over 5 percent by weight of flat, thin, elongated, friable, or laminated pieces (pieces having major dimension over 5 times average dimension) or more than 2 percent by weight of shale or cherty material. Any suitable individual grading

of coarse aggregate may be furnished, provided Grading of Combined Aggregate indicated in following table is obtained. Refer to Section 01 4200: Testing and Inspection.

GRADING OF COMBINED AGGREGATE

Sieve Number or Size in Inches	1-1/2" Maximum	1" Maximum	3/4" Maximum
Passing a 2"	-----	-----	-----
Passing a 1-1/2"	95-100	-----	-----
Passing a 1"	70-90	90-100	-----
Passing a 3/4"	50-80	70-95	90-100
Passing a 3/8"	40-60	45-70	55-75
Passing a No. 4	35-55	35-55	40-60
Passing a No. 8	25-40	27-45	30-46
Passing a No. 16	16-34	20-38	23-40
Passing a No. 30	12-25	12-27	13-28
Passing a No. 50	2-12	5-15	5-15
Passing a No. 100	0-3	0-5	0-5

- C. Water: Water for concrete mixes, curing and cleaning shall be potable and free from deleterious matter.
- D. Admixtures: Shall be shown capable of maintaining essentially the same composition and performance throughout the work as the product used in establishing concrete proportions in accordance with ACI 318, Section 26.4.
1. Admixtures containing chlorides or sulfides are not permitted.
 2. Air-entraining admixtures shall comply with ASTM C260. Air-entrained admixtures shall not be used for floor slabs to receive steel trowel finish.
 3. Admixtures for water reduction and setting time modification shall conform to ASTM C494.
 4. Admixtures for producing flowing concrete shall conform to ASTM C1017.
 5. Pozzolan: ASTM C618, Class F Fly Ash subject to the conditions in ACI 318 Section 26.4, containing two percent or less carbon. Fly ash shall not be used in excess of 15 percent by weight of total cement quantity for structural concrete except for foundations, which may use up to 25 percent fly ash by weight of total cement quantity. Fly ash need not be included in lightweight concrete mix designs.
 6. Admixtures containing ASTM C845 expansive cements shall be compatible with the cement and produce no deleterious effects.
 7. Silica fumes used as an admixture shall conform to ASTM C1240.
 8. Chemical admixtures shall conform to ACI 318 Section 26.4.1.4, type A or D, manufactured by Grace or approved equal. Type C or E admixtures may be utilized for cold weather conditions provided the admixture is compatible with all other mix materials and admixtures.
- E. Expansion Joint Fillers: Preformed strips, non-extruding and resilient bituminous type, of thickness indicated, conforming to ASTM D1751 and ASTM D1752.
- F. Curing Paper: Shall conform to ASTM C171 and consist of two sheets of kraft paper cemented together with a bituminous material in which are embedded cords or strands of fiber running in both directions. The paper shall be light in color, shall be free of visible defects, with uniform appearance, and non-staining. Liquid curing compounds may be substituted provided they are clear, conform to ASTM C 309, and comply with Rule II 13 of the South Coast Air Quality

Management District and Federal Air Quality Regulation 40 CFR 52.254, such as Master Builders, Grace, Antihydro.

- G. Floor Hardener: Water soluble, inorganic, silicate-based curing, hardening, sealing and dustproofing compound. Aquaseal W20 by Monopole Inc., Kure-N-Harden by BASF, Chem Hard by L&M, Liqui-Hard by W. R. Meadows, or equal.
- H. Underlayment: Two component latex underlayment for filling low spots in concrete for both interior and exterior applications, from featheredge to a maximum of 3/8 inch in thickness. Underlayment shall be non-shrink and suitable for repairing exposed concrete surfaces and for underlayment of carpet, resilient, tile and quarry floor coverings. La-O-Tex by TexRite, Underlay C or RS by Mer-Krete Systems, Underlayment 962 by C-Cure, or equal.
- I. Vapor Barrier: Polyolefin-based 15 mils minimum thickness, meeting or exceeding ASTM E1745, 10 feet minimum width. Permeance shall be less than 0.01 perms [grains/(ft²*hr*inHg)] as determined by ASTM E96 or ASTM F1249 and after mandatory conditioning tests per ASTM E154 Sections 8, 11, 12, & 13. Barrier shall have an impact strength greater than 70 grams per mil, and must be resistant to deterioration. Include accessories including tape and/or mastic. Stego Wrap by Stego Industries LLC, Perminator by W.R. Meadows, Ecoshield-E by Epro, or equal.
- J. Stair Strips and Nosing:
1. Fabricated from 6063-T5 extruded aluminum, mill finish. Anti-slip filler shall contain at least 60 percent virgin grain aluminum oxide abrasive. Binder shall be fully cured resilient type epoxy, with binder-to-filler ratio of 13 percent. The epoxy-abrasive filler shall extend over the curved front edge of the nosing and shall be securely bonded to the extruded aluminum base.
 2. Manufactured by Wooster Products Inc. American Safety Tread Co. Inc., or equal.
 3. Nosing and strips for concrete casting shall be provided with Sure-Hold anchors, chevron shaped continuous full length of nosing or strip.
 4. Nosings and anchors for attachment to hydrated concrete stairs and wood stairs shall be similar to those specified below, except they shall be provided with countersunk holes for screws and fasteners.
 5. Colors: As selected by Architect to contrast with stair color. Colors shall extend uniformly through the filler.
 6. Strip and Nosing Types:
 - a. Nosings for sloped riser steel pan stairs: Type WP4J, 4-1/16 inches wide, 3/8 inch thick.
 - b. Nosings for new concrete stairs: Type WP4C, 4-1/16 inches wide, 3/8 inch thick, nose projects down 1/4 inch.
 - c. Nosings for square edged steel pan stairs: Type WP4SP, 4-1/16 inches wide, 3/8 inch thick nose.
 - d. Strips for recessing into concrete stairs: Type WP1A, except 2-1/4 inches wide, 3/8 inch thick. American Safety Tread Co., Type 24, or equal.
 - e. Strips for adhering to existing or hydrated concrete: Flex-Tred anti-safety strips, minimum 2-1/4 inches wide. Cut from rolls and round corners.
 - f. Strips for anchoring into wood or stone: American Safety Tread Co., Type T-24H, or equal, with holes for fasteners, 2-1/4 inches wide.

- K. Grout: ASTM C1107, non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 7 days; of consistency suitable for application and a 30 minute working time.
- L. Construction Joint Materials: "Key-Kold" or "Kwik-Joint," of profiles indicated.
- M. Bonding Agent: "Weld-Crete," manufactured by Larsen Products Co., P.O. Box 2127, Rockville, MD 20852, Master Builders "Concresive," or equal.
- N. Epoxy Grout: Master Builders "Ceilcote 648," or equal. $f'c$ shall be equal to 125% of the concrete base design strength.
- O. Non-shrink grout:
 - 1. For concealed areas: Master Builders "Embeco 885," or equal, non-gas-forming and free of oxidizing catalysts and inorganic accelerators, used as dry or damp pack, or mixed to a 20-second flow (CRC-C 611), without segregation or bleeding at any temperature between 45 degrees F and 100 degrees F. Working time 30 minutes or more. Grout shall be flowable with an $f'c$ equal to 125% of the concrete base design strength.
 - 2. For exposed areas: Master Builders "Masterflow 928," with same characteristics as specified for concealed areas.
- P. Drypack: Field mixture of 1 part cement to 2 parts fine aggregate mixed to a damp consistency such that a ball molded in the hands will stick together and hold its shape. In lieu of field mixing, Contractor may use factory mixed drypack material, such as Master Builders "Set Grout." $f'c$ shall be equal to 125% of the concrete base design strength.

2.02 CONCRETE MIX

- A. Mix shall be signed and sealed by a Civil or Structural Engineer currently registered in the State of California.
- B. Strength of Concrete: Strengths and types of concretes shall be as indicated in the Drawings. Unless otherwise indicated or specified, concrete shall be provided with minimum 28-day strength of 3000 psi ($f'c$).
- C. The required strength and durability of concrete shall be determined by compliance with the proportioning, testing, mixing and placing provisions of ACI 301. Concrete mix shall meet the durability requirements of ACI 318, Chapter 19 and CBC Section 1905A.
- D. Concrete proportioning shall be determined on the basis of field experience and/or trial mixtures shall in accordance with ACI 301. Proportions of materials shall provide workability and consistency to permit concrete to be placed readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding.
- E. Ready-Mixed Concrete: Mix and deliver in accordance with requirements of ASTM C94. Furnish ready-mixed concrete from an approved commercial off-site plant. Use transit mixer trucks equipped with automatic devices for recording number of revolutions of drum, comply with ACI Chapter 5.
- F. Slump: Adjust quantity of water so concrete at point and time of placing does not exceed the slumps per plans when tested according to ASTM C143. Use the minimum water necessary for workability required by part of structure being cast.

- G. Admixtures: All approved admixtures shall be introduced into the concrete at the batch plant. Field additions are not acceptable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Surfaces to receive concrete shall be free of debris, standing water, and any other deleterious substances before start of concrete placing.
- B. Time of Placing: Do not place concrete until reinforcement, conduits, outlet boxes, anchors, hangers, sleeves, bolts, and other embedded materials are securely fastened in place. Contact the IOR at least 24 hours before placing concrete; do not place concrete until inspected by the IOR.
- C. Pouring Record: A record shall be kept on the Project site of time and date of placing concrete in each portion of structure. Such record shall be maintained on the Project site until Substantial Completion and shall be available for examination by the Architect and DSA.

3.02 TOLERANCES

- A. Concrete construction tolerances shall be as specified in ACI 117 and as modified herein.
- B. Floor Flatness (FF) and Floor Levelness (FL) shall be as indicated below:

	Specified Overall Value		Minimum Local Value	
	F _F	F _L	F _F	F _L
Slabs on ground: mechanical and electrical rooms, parking structures and mortar bed set tile and quarry flooring.	20	15	15	10
Slab on ground: carpet.	25	20	17	15
Slab on ground: thinset tile and resilient flooring, polished concrete	35	25	24	17
Suspended slabs: mechanical and electrical rooms, parking structures and mortar bed set tile and quarry flooring.	20	15	N/A	N/A
Suspended slabs: carpet.	25	20	N/A	N/A
Topping slabs: polished concrete	35	25	N/A	N/A
Suspended slabs: thinset tile and resilient flooring.	35	20	N/A	N/A

- C. Refer to ACI 302.1R, Tables 8.1 and 8.2 Slab on Ground and Suspended Flatness/Levelness Construction Guide, for recommended concrete placing and finishing methods.

- D. Floor Flatness and Floor Levelness shall be tested in accordance to ASTM E1155. Floor measurements shall be made within 72 hours after slab installation, and shall precede removal of shores and forms.
- E. Floor levelness (FL) requirements are not applicable to concrete placed directly over unshored bare metal decking. These requirements are applicable for the topping slab placed over the structural composite floor decks.

3.03 PREPARATION

- A. Vapor Barrier: Before installation of screeds and slab reinforcement, install vapor barrier under slabs on grade, as indicated in the drawings.
 - 1. Install in accordance to ASTM E1643.
 - 2. Place vapor retarder sheeting with the longest dimension parallel with the direction of the concrete pour.
 - 3. Laps or seams shall be overlapped 12 inches, or as recommended by manufacturer. Laps and penetrations shall be sealed with the manufacturer's recommended tape and/or mastic.
 - 4. Extend membrane and lap at least 4 inches onto adjoining wall surfaces and seal with pressure-sensitive tape.
 - 5. IOR will inspect and mark areas of damage and insufficient installation of the vapor barrier sufficiently in advance of concrete placement.
 - a. Deficiencies shall be corrected before concrete is placed.
 - b. Patch damaged areas with vapor barrier overlapping all four sides 6 inches and adhering with tape.
- B. Reglets and Rebates:
 - 1. Form reglets and rebates in concrete to receive flashing, frames and other equipment as detailed and required. Coordinate dimensions and locations required with other related Work.
 - 2. If concrete slabs on grade adjoin a wall or other perpendicular concrete surface, form a reglet in wall to receive and carry horizontal concrete Work. Reglet shall be full thickness of the slab and shall be 3/4 inch wide, unless otherwise indicated. Requirement does not apply to exterior walks, unless specifically indicated.
- C. Screeds: Install screeds accurately and maintain at required grade or slab elevations after steel reinforcement has been installed, but before starting to place concrete. Install screeds adjacent to walls and in parallel rows not to exceed 8 feet on centers.
- D. Screeds over Vapor Barrier: Use weighted pad or cradle type screeds and do not drive stakes through the vapor barrier. Check with an instrument level, transit, or laser.
- E. Remove all free water from forms before concrete is deposited. Remove hardened concrete, debris, and foreign materials from interior surfaces of forms, exposed reinforcing, and from surfaces of mixing and conveying equipment.
- F. Wetting: Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to reduce adsorption and to help maintain concrete workability.
- G. Earth Subgrade: Dampen 24 hours before placing concrete, but do not muddy. Re-roll where necessary for smoothness and remove loose material.

- H. Gravel Fill: Recompact disturbed gravel and bring to correct elevation.
- I. Sand Beds or Subslab Drainage Fill: Recompact disturbed material and bring to correct elevation.
- J. Composite Steel Beams: Provide shores for tributary construction loads to floor and roof beams as required, or camber the beams as approved by Architect.
- K. All concrete shall be thoroughly consolidated by suitable means during placement and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms.

3.04 INSTALLATION

A. Conveying and Placing:

1. Do not place concrete until reinforcing steel and forms or decks have been approved by the Inspector and other authorities having jurisdiction. Concrete shall be placed only under direct observation of the IOR. Do not place concrete outside of regular working hours, unless the IOR has been notified at least 48 hours in advance.
2. Concrete shall be conveyed from mixer to location of final placement by methods that will prevent separation or loss of materials. Place concrete in horizontal layers not more than 18" thick within 90 minutes after water is first added to the batch.
3. Concrete shall be placed as nearly as practicable to its final position to avoid segregation due to re-handling or flowing. No concrete that has partially hydrated or has been contaminated by foreign materials shall be placed, nor shall re-tempered concrete or concrete which has been remixed after initial set be placed.
4. In placing concrete in columns, walls or thin sections, provide openings in forms, elephant trunks, tremies or other recognized devices, to prevent segregation and accumulation of partially hydrated concrete on forms or metal reinforcement above level of concrete being placed. Such devices shall be installed so that concrete will be dropped vertically.
5. Concrete shall be placed as a continuous operation until placing of panel or section is completed. Top surfaces of vertically formed lifts shall be level.
6. Concrete shall be thoroughly consolidated by suitable means during placement, and shall be thoroughly worked around reinforcement and embedded fixtures with mechanical vibrators and into corners of forms.
7. Where conditions make consolidation difficult, or where reinforcement is congested, batches of concrete adjusted to use smaller size aggregates than specified in the mix design shall be used as approved by the Architect and Structural Engineer.
8. Where new concrete is placed against or on old or existing concrete, apply bonding agent to surface of old concrete prior to placement of new concrete.
9. Comply with ACI 301.

B. Cold Weather:

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. All ground with which concrete is to come in contact shall be free from frost. No frozen materials or materials containing ice shall be used.
2. The temperature of concrete at the time of placement shall not be below the minimum temperatures given in Table 3.1 of ACI 306.1.

3. Concrete shall be maintained at a temperature of at least 50° F. for not less than 72 hours after placing or until it has thoroughly hardened. Cover concrete and provide sufficient heat as required. When necessary, aggregates shall be heated before mixing. Special precautions shall be taken for protection of transit-mixed concrete.

C. Hot Weather:

1. Concrete to be placed during hot weather shall comply with the requirements of ACI 301.
2. Maintain concrete temperatures indicated in Table 2.1.5 of ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square feet of exposed concrete per hour.
3. Cool concrete using methods indicated in ACI 305R Appendix B.
4. Place and cure concrete as specified in ACI 305R Chapter 4.

D. Compaction and Screeding:

1. Tamp freshly placed concrete with a heavy tamper until at least 3/8 inch of mortar is brought to surface. Concrete shall then be tamped with a light tamper and screeded with a heavy straightedge until depressions and irregularities are eliminated, and surface is true to finish grades or elevations. Remove excess water and debris.
2. Where slabs are to receive separate cement finish or mortar setting bed, continued tamping to raise mortar to surface is not performed. Laitance shall be removed by brushing with a stiff brush or by light sandblasting to expose clean top surface of coarse aggregate.
3. Compacting: Compact each layer of the concrete as placed with mechanical vibrators or equivalent equipment. Transmit vibration directly to concrete and in no case through the forms unless approved. Accomplish thorough compaction. Supplement by rodding or spading by hand adjacent to forms. Compact concrete into corners and angles of forms and around reinforcement and embedded fixtures. Recompact deep sections with congestion due to reinforcing steel as required.
4. Operation of Vibrators: Do not horizontally transport concrete in forms with vibrators nor allow vibrators to contact forms or reinforcing. Push vibrators vertically into the preceding layers that are still plastic and slowly withdraw, producing maximum obtainable density in concrete without creating voids or segregation. In no case disturb concrete that has partially set. Vibrate at intervals not exceeding two-thirds the effective visible vibration diameter of the submerged vibrator. Avoid excessive vibration that causes segregation. Provide sufficient vibration and/or revibration at thick foundations to prevent plastic settlement effects during curing.

E. Floating and Troweling:

1. When concrete has hydrated sufficiently, it shall be floated to a compact and smooth surface. After floating, wait until concrete has reached proper consistency before troweling. Top surfaces shall receive at least 2 troweling operations with steel hand trowel. Prior to and during final troweling, apply a fine mist of water frequently with an atomizing type fog sprayer. Omit troweling for slabs to receive a separate cement finish.
2. For interior finish slabs, final troweling shall provide a hard, impervious, and non-slip surfaces, free from defects and blemishes. Finished surface shall be within tolerances indicated in Article 3.02. Avoid burnishing. Do not add cement or sand to absorb excess moisture.
3. Exterior Paving and Cement Walks: Finish as specified above, except surface shall be given a non-slip broom finish to match Sample reviewed by the Architect.

4. Non-architectural vertical concrete surfaces shall be finished smooth and free from marks or other surface defects.
- F. Curing:
1. Length of time, temperature and moisture conditions for curing concrete shall be in accordance with ACI 301.
 2. Forms containing concrete, top of concrete between forms, and exposed concrete surfaces after removal of forms shall be maintained in a thoroughly wet condition for at least 7 consecutive days after placing. Use the water curing method, curing sheet material, or a clear liquid membrane-forming curing compound except as otherwise specified.
 3. If weather is hot or surface has dried out, spray surface of concrete slabs and paving with fine mist of water, starting not later than 2 hours after final troweling and continuing until sunset. Surface of finish shall be kept continuously wet until curing medium has been installed.
 4. Immediately after finishing, monolithic floor slabs shall be covered with curing paper. Paper shall be lapped 4 inches at joints and sealed with waterproof sealer. Edges shall be cemented to finish. Repair or replace paper damaged during construction operations.
 5. Within 24 hours after finishing, exterior slabs and paving, and interior slabs to receive cement topping or mortar setting beds, shall be covered with sand to a depth of 2 inches and kept thoroughly wet for 7 days. Instead of sand covering, exterior walks and paving where no other surface treatment is specified, may be cured with clear liquid curing compound immediately installed in accordance with manufacturer's directions.
- G. Filling, Leveling and Patching:
1. Fill and patch as required to meet as-cast finish requirements of ACI 301 Section 5.3.3.5.
 2. Concrete slabs exhibiting high or low spots and indicated to receive resilient floor covering or soft floor covering, shall have surfaces repaired. High spots shall be honed, or ground with power-driven machines to required tolerances. Low spots shall be filled with latex underlayment, installed in strict accordance with manufacturer's written recommendations.
 3. Holes resulting from form ties or sleeve nuts shall be solidly packed, through exterior walls, by pressure grouting with cement grout, as specified. Grouted holes on exposed surfaces shall be screeded flush and finished to match adjoining surfaces.
- H. Cement Base: Cement base shall be of the height, thickness, and shape detailed. Base shall be reinforced with one inch mesh, 18 gage, zinc-coated wire fabric. Base finish mixture shall be one part cement, 2 parts of fine aggregate and one part pea gravel. Colored cement base shall include a chemically inert mineral oxide pigment in the mix.
- I. Joints: Comply with ACI 318 Section 6.4. Locate joints in concrete only where shown or approved and obtain prior approval for points of stoppage of any pour. Clean and roughen surface of construction joints by removing entire surface and exposing 1/4" of clean coarse aggregate solidly embedded in mortar matrix by chipping, use of an approved retarder agent, or equal. Water and keep hardened concrete wet for not less than 24 hours before placing the next lift or abutting concrete. Cover the horizontal surfaces of existing or previously placed and hardened concrete with a 2" thick layer of fresh concrete of required mix less 50 percent of coarse aggregate just before balance of concrete is placed.
- J. Vertical Elements: Stop placement of concrete in walls and columns 1-1/2" below bottom of beams or supported slabs. Stop placement at sills and heads of wall openings in the same

manner. Allow concrete in vertical elements to be in place at least 2 hours and until vertical settlement has ceased before placing concrete for floor framing.

- K. Correction of Segregation: Before placing next layer of concrete, and at the top of each placement for vertical elements, remove all concrete containing excess water or fine aggregate, or showing deficiency of coarse aggregate, and fill the space with compacted concrete of correct proportions. Comply with ACI 318 Section 6.4.

3.05 3.05 FINISHING

- A. Soda and Acid Wash: Concrete surfaces to receive plaster, paint or other finish, and which have been formed by oil coated forms, shall be scrubbed with a solution of 1-1/2 pounds of caustic soda to one gallon of water. Surfaces where smooth wood or waste molds have been furnished shall be scrubbed with a solution of 20 percent muriatic acid. Wash with clean water after scrubbing.
- B. Sacking: Where required by the Architect, exposed concrete curbs, walls, and other surfaces shall be sacked by an application of cement grout, floated, and rubbed. Sacking shall not be performed until patching and filling of holes has been completed. Entire sacking operation for any continuous area shall be started and completed within the same day.
 - 1. Mix one part cement and 1-1/2 parts fine sand with sufficient water to produce a grout having consistency of thick paint. Wet surface of concrete sufficiently to prevent absorption of water from grout. Apply grout uniformly with a brush or spray gun, then immediately float surface with a cork or other suitable float, scouring wall vigorously.
 - 2. While grout is still plastic, finish surface with a sponge-rubber float, removing excess grout. Allow surface to dry thoroughly, then rub vigorously with dry burlap to completely remove dried grout. No visible film or grout shall remain after rubbing with burlap.
- C. Abrasive: Concrete stair treads, landings, ramps and steps on interior and exterior of buildings, and interior exposed concrete floors in shop buildings shall receive an abrasive finish. Abrasive grains in amount of 30 pounds per 100 square feet shall be evenly installed by dust-on method and embedded into surface during first troweling operation. Additional abrasive grains, in amount of 30 pounds per 100 square feet, shall then be evenly installed and embedded into surface during final troweling operation.
- D. Floor Hardener: Exposed interior concrete floors throughout shall be treated with floor hardener, as specified. Install hardener after surface of concrete has reached the point where no excess moisture is present, but while it is still plastic. Hardener shall be installed as follows:
 - 1. Protect adjacent surfaces. Clean surfaces to receive treatment in accordance with manufacturer's instructions, ensuring that all stains, oil, grease, form release agents, laitance, dust and dirt are removed prior to application.
 - 2. Apply hardener in accordance with manufacturer's instructions as soon as concrete is firm enough to work on after final troweling.
 - 3. Colored Hardener: Install at rate of 40 pounds per 100 square feet of surface for initial application.
 - 4. Gray (natural) Hardener: Install at rate of 20 pounds per 100 square feet of surface for initial application.
 - 5. Hardener shall be evenly distributed and thoroughly floated into surface mortar with a wood float. An additional 20 pounds of hardener, colored or gray, specified as above, shall be installed over each 100 square feet, and troweled to an even surface having uniform color and texture.

- E. Cement Grout and Dry-Pack Concrete: Cement grout shall be mixed at the Project site and shall be composed of one volume of cement and 2-1/2 volumes of fine aggregate. Materials shall be mixed dry with sufficient water added to make mixture flow under its own weight. When grout is used as a dry pack concrete, add sufficient water to provide a stiff mixture, which can be molded into a sphere.
- F. Broom Finish: Exterior stair treads and landings shall be provided with a non-slip broom finish in addition to abrasive finish specified.
- G. Abrasive Stair Nosing: Nosing shall be installed according to manufacturers written recommendations.

3.06 GROUTING AND DRYPACKING

- A. Install as indicated or required. Where grouting and drypacking is part of the work of other sections, it shall conform to the following requirements, as applicable.
- B. Drypacking: Mix materials thoroughly with minimum amount of water. Install drypack by forcing and rodding to fill voids and provide complete bearing under plates. Finish exposed surfaces smooth and cure with damp burlap or liquid curing compound.
- C. Non-Shrink Grouting:
 - 1. Mixing: Mix the approved non-shrink grout material with sufficient water per manufacturers recommendations.
 - 2. Application: Surfaces to receive the non-shrink grout shall be clean, and shall be moistened thoroughly immediately before placing the mortar. Before grouting, surfaces to be in contact shall be roughened and cleaned thoroughly, all loose particles shall be removed and the surface flushed thoroughly with neat cement grout immediately before the grouting mortar is placed. Place fluid grout from one side only and puddle, chain, or pump for complete filling of voids; do not remove the dams or forms until grout attains initial set. Finish exposed surfaces smooth, and cure as recommended by grout manufacturer.

3.07 EXPANSION AND CONSTRUCTION JOINTS

- A. Construction Joints: Details and proposed location of construction joints shall be as indicated on the Drawings, located to least impair strength of structure, in accordance with the following:
 - 1. Thoroughly clean contact surface.
 - 2. A mix containing same proportion of sand and cement provided in concrete plus a maximum of 50 percent of coarse aggregate shall be placed to a depth of at least one inch on horizontal joints. Vertical joints shall be wetted and coated with a neat cement grout immediately before placing of new concrete.
 - 3. Should contact surface become coated with earth, sawdust, or deleterious material of any kind after being cleaned, entire surface shall be re-cleaned before applying mix.
 - 4. Roughening may also be achieved by applying Rugasol Surface Retardant followed by water blasting.
- B. Expansion Joints: Provide expansion joints where indicated in walks and exterior slabs occurring on grade. Space approximately 20 feet apart (12 feet apart at traffic areas), unless otherwise indicated. Joints shall extend entirely through slab with joint filler in one piece for width of walk or slab. Joint filler shall be 3/8 inch thick, unless otherwise indicated.

- C. Tooled Joints: Slabs on grade, walks and paving on grade shall be marked into areas as indicated with markings made with a V-grooving tool. Marks shall be round-edged, free from burrs or obstructions, with clean cut angles and shall be straight and true. Walks, if not indicated, shall be marked off into rectangles of not more than 12 square feet and shall have a center marking where more than 5 feet wide.

3.08 FIELD QUALITY CONTROL

- A. Comply with pertinent provisions of section 01 4200.
- B. Continuous Inspection: Construct structural concrete under continuous inspection of Project Inspector. Obtain approval of forms and reinforcing as required by the Inspector before placing structural concrete.
- C. Molded Cylinder Tests:
 - 1. IOR or testing lab personnel will prepare cylinders and perform slump tests. Samples for concrete strength shall be taken in accordance to ASTM C172. Each cylinder shall be dated, given a number, point in structure from which sample was obtained, mix design number, mix design strength and result of accompanying slump test noted.
 - 2. Separate tests of molded concrete cylinders obtained at same place and time shall be made at age of 3 days, 7 days, and 28 days. A strength test shall be the average of the compressive strength of 2 cylinders, obtained from the same sample of concrete and tested at 28 days or at test age designated for determination of f'_c . Retain one additional cylinder from each location to be tested in the event that the initial 2 cylinder test does not meet the project requirements. High fly ash concrete mixes may be tested at 42 days in lieu of 28 days.
 - 3. Test cylinders shall be prepared at the Project site and stored in testing laboratory in accordance with ASTM C31, and tested in accordance with ASTM C39.
 - 4. Frequency of testing shall conform to ACI 318 Section 26.12 and CBC Section 1905A.1.16 as a minimum requirement.
 - 5. Control Test Cylinders: Cast a set of two or more cylinders for each day's placing of concrete for slabs supported on shoring. Place test cylinders on slabs represented by cylinders and cure the same as slabs. Test cylinders to determine proper times for removal of shores and reshoring. A strength test shall be the average of the compressive strengths of 2 cylinders made from the same sample of concrete and tested at 28 days.
- D. Concrete Consistency: Measure consistency according to ASTM C143. Test twice each day or partial day's run of the mixer.
- E. Adjustment of Mix: If the strength of any grade of concrete for any portion of Work, as indicated by molded test cylinders, falls below minimum 28 days compressive strength specified or indicated, adjust mix design for remaining portion of construction so that resulting concrete meets minimum strength requirements.
- F. Air Content Testing: Measure in accordance to ASTM C173 or ASTM C231, for each composite sample taken in accordance to ASTM C172.
- G. Defective Concrete:
 - 1. Should strength of any grade of concrete, for any portion of Work indicated by tests of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective Work and shall be replaced or adequately strengthened in a manner acceptable to the Architect and DSA.

2. Concrete Work that is not formed as indicated, is not true within 1/250 of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, contains sawdust shavings, wood or embedded debris, or does not fully conform to Contract provisions, may be deemed to be defective Work and subject to removal and replacement if reasonable repair work cannot resolve the defects.
- H. Concrete for Equipment Pads, Mechanical and Electrical Work: Unless otherwise indicated, strength shall have a minimum $f'c = 3,000$ psi. Exposed concrete shall be provided with a hand trowel finish with radius corners and edges. Form and place concrete where necessary as described in Section 03 1000: Concrete Forms and Accessories, and reinforced as described in Section 03 2000: Concrete Reinforcement. Calcium chloride shall not be furnished in any concrete mix provided for the installation of underground electrical conduits. For concrete encasement of more than one conduit, furnish 3/4 inch maximum aggregate.
 - I. Level of Floors: Continuously monitor concrete placing to maintain level floor by use of an instrument level, transit, or laser.
- 3.09 CLEAN UP
- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.
- 3.010 PROTECTION
- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

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SECTION 03 33 00

CAST-IN-PLACE ARCHITECTURAL CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes cast-in-place architectural concrete, including form facings, reinforcement and accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

- 1. Requirements in Section 03 30 00 "Cast-in-Place Concrete" apply to architectural concrete.

- B. Related Requirements:

- 1. Section 03 30 00 "Cast-in-Place Concrete" for concrete not designated as architectural concrete.

1.03 DEFINITIONS

- A. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- C. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
- D. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.
- E. W/C Ratio: The ratio by weight of water to cementitious materials.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

- 1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.

- c. Ready-mix concrete manufacturer.
 - d. Cast-in-place architectural concrete Subcontractor.
2. Review [concrete finishes and finishing,] [cold- and hot-weather concreting procedures,] [curing procedures,] [construction joints,] [forms and form-removal limitations,] [reinforcement accessory installation,] [concrete repair procedures,] and protection of cast-in-place architectural concrete.
 3. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Formwork Shop Drawings: Show formwork construction, including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
- D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints, including construction joints.
- E. Samples: For each of the following materials:
 1. Form-facing panels.
 2. Form ties.
 3. Form liners.
 4. Exposed aggregates.
 5. Coarse- and fine-aggregate gradations.
 6. Chamfers and rustications.
- F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[manufacturer] [testing agency]**.
- B. Material Certificates: For each of the following, signed by manufacturers:
 1. Cementitious materials.

2. Admixtures.
 3. Form materials and form-release agents.
 4. Repair materials.
- C. Material Test Reports: For the following, by a qualified testing agency:
1. Aggregates. [Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.]
- D. LEED Documentation: Submit documentation showing design compliance.
- 1.07 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, **[acceptable to authorities having jurisdiction,]** qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
 2. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.
 3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
 4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove field sample panels when directed.
- D. Mockups: Before casting architectural concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Build mockups of typical exterior wall of cast-in-place architectural concrete as shown on Drawings.
3. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
4. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
5. Obtain Architect's approval of mockups before casting architectural concrete.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.09 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
- B. Hot-Weather Placement: Comply with ACI 301 and as follows:
 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 303.1.

2.02 FORM-FACING MATERIALS

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for formwork and other form-facing material requirements.
- B. Source Limitations: Obtain each type form-facing material from single source from single manufacturer.
- C. Form-Facing Panels for **[As-Cast] [Exposed-Aggregate]** Finishes: Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- D. Form-Facing Panels for **[As-Cast] [Exposed-Aggregate]** Finishes: Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, **[high-density overlay, Class 1, or better] [medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed]**, complying with DOC PS 1 **[, or Finnish phenolic overlaid birch plywood]**.
- E. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- F. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- G. Form Liners: Units of face design, texture, arrangement, and configuration **[indicated] [to match design reference sample]**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
- H. Rustication Strips: Metal **[, dressed wood,]** or rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
- I. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; nonstaining; in longest practicable lengths.
- J. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch thick.
- K. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.
- L. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
- M. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- N. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
- O. Form Ties: Factory-fabricated, **[glass-fiber-reinforced plastic] [internally disconnecting] [or] [removable]** ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish ties **[with tapered tie cone spreaders]** that, when removed, will leave holes **[3/4 inch] [1 inch] [1-1/4 inches] [1-1/2 inches] <Insert dimension>** in diameter on concrete surface.
 2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches **[, after exposing aggregate,]** from the architectural concrete surface.
 3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch in diameter, of color **[to match Architect's sample] [selected by Architect from manufacturer's full range]**.
 4. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice."
1. Where legs of wire bar supports contact forms, use **[gray, all-plastic] [CRSI Class 1, gray, plastic-protected] [or] [CRSI Class 2, stainless-steel]** bar supports.

2.04 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
1. Portland Cement: ASTM C 150/C 150M, **[Type I] [Type II] [Type I/II] [Type III], [gray] [white]**.
 2. Fly Ash: ASTM C 618, **[Class C] [Class F]**.
 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or Grade 120.
 4. Silica Fume: ASTM C 1240 amorphous silica.
 5. Blended Hydraulic Cement: ASTM C 595/C 595M, **[Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type IL, portland-limestone] [Type IT, ternary blended] cement.**

- C. Normal-Weight Aggregates: ASTM C 33/C 33M, **[Class 5S] [Class 5M] [Class 1N]** <Insert class> coarse aggregate or better, graded. Provide aggregates from single source **[with documented service-record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials]**.
1. Maximum Coarse-Aggregate Size: **[1 inch] [3/4 inch] [1/2 inch] [3/8 inch]**.
 2. Gradation: **[Uniformly] [Gap]** graded.
- D. Normal-Weight Fine Aggregate: **[ASTM C 33/C 33M] [or] [ASTM C 144]**, manufactured or natural sand, from same source for entire Project.
- E. Air-Entraining Admixture: ASTM C 260/C 260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that does not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- G. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, **[free of carbon black,]** nonfading, and resistant to lime and other alkalis.
1. Color: **[As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range]**.
- H. Water: Potable, complying with ASTM C 94/C 94M, except free of wash water from mixer washout operations.

2.05 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
1. For integrally colored concrete, curing compound shall be **[pigmented type]** approved by color pigment manufacturer.
 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.06 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881/C 881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
 - 1. **[Types I and II, nonload bearing] [Types IV and V, load bearing]**, for bonding hardened or freshly mixed concrete to hardened concrete.

2.07 CONCRETE MIXTURES

- A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.
- B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
- C. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. **[Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.]**
- D. Limit water-soluble, chloride-ion content in hardened concrete to **[0.06] [0.15] [0.30] [1.00]** percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
- F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- G. Concrete Mixtures:
 - 1. Compressive Strength (28 Days): **[5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi]**.
 - 2. Maximum W/C Ratio: 0.46.
 - 3. Slump Limit: **[3 inches] [4 inches] [8 inches]** for concrete with verified slump of **2 to 4 inches** before adding high-range water-reducing admixture or plasticizing admixture] <Insert dimension(s)>, plus or minus 1 inch.
 - 4. Air Content: **[5-1/2] <Insert number>** percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
 - 5. Air Content: **[6] <Insert number>** percent, plus or minus 1.5 percent at point of delivery for **[1-inch] [3/4-inch]** nominal maximum aggregate size.

2.08 CONCRETE MIXING

- A. **[Ready-Mixed] [or] [Site-Mixed]** Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
 2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 FORMWORK INSTALLATION

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.
- B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
- C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
1. **[Class A, 1/8 inch] [Class B, 1/4 inch] [Class C, 1/2 inch]**.
- D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ASI 117M).
1. Also comply with the following tolerances: **<Insert tolerances>**.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
 2. Do not use rust-stained steel form-facing material.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. **[Chamfer] [Do not chamfer]** exterior corners and edges of cast-in-place architectural concrete.
- H. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- M. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
- N. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form-liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.02 REINFORCEMENT AND INSERT INSTALLATION

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.03 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Schedule form removal to maintain surface appearance that matches approved **[field sample panels] [mockups]**.
 - 2. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved **[28-day design compressive strength] [at least 70 percent of 28-day design compressive strength]**. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.04 JOINTS

- A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 - 2. Form keyed joints as indicated. **[Embed keys at least 1-1/2 inches into concrete.]** Align construction joint within rustications attached to form-facing material.

3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls **[as indicated]** <Insert spacing>. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use **[bonding agent]** **[epoxy-bonding adhesive]** at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.05 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

3.06 FINISHES, GENERAL

- A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
 1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

- C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.07 AS-CAST FORMED FINISHES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. **[Repair] [Do not repair]** and patch tie holes and defects.
- C. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

3.08 EXPOSED-AGGREGATE FINISHES

- A. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi, apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample or mockup.
- B. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
 - 1. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample or mockup.

- C. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
1. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.
 2. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.
 3. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample or mockup, as follows:
 - a. Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
 - b. Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch.
 - c. Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch.
 - d. Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch.
- D. Bushhammer Finish: Allow concrete to cure at least 14 days before starting bushhammer surface finish operations.
1. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.
 2. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
 3. Remove impressions of formwork and form facings with exception of tie holes.

3.09 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
- B. Begin curing cast-in-place architectural concrete immediately after **[removing forms from]** **[applying as-cast formed finishes to]** concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.

- b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
- 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - 3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

- A. General: Comply with field quality-control requirements in Section 03 30 00 "Cast-in-Place Concrete."

3.11 REPAIR, PROTECTION, AND CLEANING

- A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
 - 1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.
- B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
- C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
- D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
 - 1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION

SECTION 03 35 00

INTERIOR CONCRETE FLOOR SEALER

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Surface preparation.
 - 2. Application of clear concrete sealer on exposed surfaces of the interior concrete floors indicated.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation meeting:
 - 1. Prior to start of installation, arrange a pre-installation meeting between the sealer manufacturer, the applicator, and related trades whose work will be in contact with the treated surface, including but not limited to those for colored concrete and joint sealers.
 - 2. Record minutes of the meeting, file in the Project file, and send a copy to the Architect.
- B. Phasing
 - 1. Where feasible delay sealer application until installation of sealants is complete in joints adjoining surfaces to be coated.
 - 2. Sealer work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, sealer, and sealant materials identical to those used in the Work.

1.03 SUBMITTALS

- A. Data: Manufacturer Product Data of the proposed sealer, including recommended coverage rates, include material test reports indicating and interpreting test results for compliance of water-repellent sealer with criteria specified.
- B. Manufacturer certification:
 - 1. Letter from the sealer manufacturer to verify its acceptance of the applicator, acceptance of substrates as satisfactory to receive the specified sealer, and affidavit that sealer is compatible with concrete curing agent used.
 - 2. Duplicate copies of manufacturer affidavit with each shipment of materials delivered to the jobsite certifying that material furnished complies with specified requirements.

1.04 QUALITY ASSURANCE

- A. Installer qualifications: Firm with a minimum of 3 consecutive years of experience in application of the sealer proposed for use, or similar sealers, on projects of similar size and scope, and licensed or approved in writing by the sealer manufacturer.
- B. Sample panels: When requested by the sealer manufacturer, or necessary to adjust sealer formulation, provide sealer manufacturer with sufficient samples of substrate to be coated to determine exact formulation and coverage rates.

C. Manufacturer inspections:

1. Obtain materials only from manufacturer who will send a qualified technical representative to the Project site before start of this work to verify substrate acceptability. Schedule subsequent visits as required thereafter to review installation procedures and completed work, and to issue warranty specified.
2. Unsatisfactory conditions disclosed by the manufacturer visits to the site shall be promptly and satisfactorily repaired and the areas re-inspected by the manufacturer before work starts or resumes in affected areas.

1.05 JOB CONDITIONS

- A. Comply with manufacturer's recommendations regarding environmental requirements, and temperature and conditions of surfaces to receive sealer.

PART 2 PRODUCTS

2.01 SEALER/MANUFACTURER

- A. Basis of design is Liqui-Hard Ultra manufactured by W. R. Meadows or equal by one of the following:
 1. Consolideck LS by Prosoco,
 2. Hydrozo Silane 40 VOC by BASF.
 3. Seal Hard by L&M Construction Chemicals, Inc.
 4. L3000 by Pecora Corp.
 5. Or equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Provide sealer with the following properties based on testing manufacturer standard products, according to test methods indicated, applied to substrates simulating Project conditions using same materials and application methods to be used for Project.
 1. Absorption: Minimum 90 percent reduction of absorption after 24 hours in comparison of treated and untreated specimens for hardened concrete: ASTM C 642.
 2. Water-vapor transmission: Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, ASTM E 96.
 3. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, ASTM G 53.
 4. Permeability: Minimum 80 percent breathable in comparison of treated and untreated specimens, ASTM D 1653.
- B. Appearance: When compared visually to an untreated sample under same lighting conditions, the sealer shall not change the color and sheen of the coated substrate and shall be invisible after application and over the life of the building.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Obtain the services of a factory-authorized technical service representative, from the sealer manufacturer, to inspect and approve the substrates before application and to instruct the applicator on the product and application method to be used.
- B. Verify that slabs to be sealed are clean, dry and free of dust, dirt, oil, grease and other foreign material that would affect the application and performance of the sealer.
- C. Correct detrimental conditions before proceeding with installation.

3.02 PROTECTION

- A. Protect adjacent work, including sealant bond surfaces, from spillage or blow-over of sealer.

3.03 APPLICATION

- A. Test application:
 - 1. Before performing this work, including bulk purchase and delivery of products, prepare a small application in an unobtrusive location and in a manner approved by Architect to demonstrate the final effect (visual, physical, and chemical) of planned application.
 - 2. Proceed with work only after Architect review of test application.
- B. Sealer shall be applied by manufacturer-approved applicators using recommended methods and equipment. Do not exceed the application rate recommended by the manufacturer.
- C. Do not dilute concrete densifier and chemical hardener.
- D. Fresh Concrete
 - 1. Apply undiluted concrete densifier and chemical hardener as soon as concrete is firm enough to work on after final troweling.
 - 2. Apply undiluted concrete densifier and chemical hardener at approximately 650 - 800 ft.²/gal. using a low-pressure sprayer.
 - 3. Do not allow material to puddle on the surface.

3.04 FIELD QUALITY CONTROL

- A. The Owner may employ a testing agency to test the in-place sealer in compliance with standards specified.
- B. The Owner will pay cost of test, except when test discloses that the sealer tested does not comply with these Specifications; the Contractor shall pay subsequent retests until application meets Specifications requirements.
- C. In the event test shows that the sealer is deficient, apply additional sealer.
- D. Repetition of the above procedure on all previously treated surfaces will be at Contractor's expense.

3.05 CLEANING

- A. Clean sealer from adjacent surfaces immediately after spillage.
- B. Comply with manufacturer's recommendations for cleaning.

END OF SECTION

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SECTION 03 35 45

POLISHED AND STAINED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Dye-stained cast-in-place concrete (SC-1).
 - 2. Supervising the work of Section 03 30 00 to obtain finished surfaces complying with the concrete stain manufacturer's instructions.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation meeting: < Insert >
- B. Sequencing: Immediately after casting slabs, protect those scheduled to receive colored finish from unplanned stains and other damage. Cover slabs with impermeable, non-staining coverings, or ban all traffic from slabs until colored staining, sealing and temporary protection is completed.
 - 1. Discoloration, soil, and spots, such as those caused by gypsum board taping and finishing compounds, mortar, paint, etc., will not be concealed by the concrete stain and must be completely removed before stain is applied.
 - 2. Grind, acid-etch or take other measures acceptable to the Architect and the stain manufacturer, at no additional cost to the Owner, to clean slabs before applying penetrating stain.

1.03 SUBMITTALS

- A. Data:
 - 1. Manufacturer Product Data and specifications for concrete stain and color-matched sealing materials.
 - 2. Include instructions for surface preparation and application of stain, together with precautions to be taken while using the product.
- B. Samples:
 - 1. Color Samples on concrete < Insert > from the concrete stain manufacturer's standard color palette for color selection by the Architect.
 - 2. When selection is made, submit 12-inch square by approximately one-inch thick concrete Samples of selected colors.
- C. Certificates: Prior to beginning the work of this Section, submit letter from concrete stain manufacturer stating proposed materials to be used are compatible with curing compounds, sealers and materials used in the concrete mixes, and will not negatively affect concrete color, finishing characteristics, quality, durability or performance.
- D. Certifications: Duplicate copies of manufacturer's affidavit with each shipment of materials delivered to the jobsite certifying that material furnished complies with specified requirements.

- E. Qualification statements: Letter from the manufacturer verifying its acceptance of concrete stain applicator.

1.04 QUALITY ASSURANCE

- A. Uniformity: Obtain all concrete stain used for the Project from the same manufacturer.
- B. Applicator's qualifications:
 - 1. Firm and individuals with a minimum of 3 consecutive years of experience in the application of specified products on projects similar in material, design, complexity and extent to this Project, and whose work has resulted in applications with a record of successful in-service performance.
 - 2. Only a firm authorized, certified, licensed, or otherwise qualified by the concrete stain manufacturer as having the necessary experience, staff, and training to install manufacturer's products shall install concrete stain materials.
 - 3. Only those installer's personnel trained and authorized by concrete stain manufacturer in the procedures pertaining to the application of concrete stain shall perform the Work of this Section.
- C. Regulatory requirements: Coefficient of friction of colored concrete paving shall be not less than 0.6 for level surfaces and 0.8 for ramps when tested in compliance with ASTM C 1028 (field test) or ASTM D 2047 (laboratory test).
- D. Mockup:
 - 1. Before beginning work, cast a 10-foot square concrete panel at a location on the site acceptable to the Architect to demonstrate color, finish and slip resistance.
 - 2. Use the same personnel, materials and construction techniques intended to be used for the Project, including the selected cement, aggregates, form materials and curing compounds.
 - 3. Architect will review the mockup to determine if the Work falls within acceptable ranges for mottling, color and texture variation, unevenness, appearance and workmanship. Final acceptance of colors will be made from mockup Samples.
 - 4. Make corrections requested by the Architect or remove and replace mockup when corrective work is not acceptable. Repeat mockup(s) until Architect's approval is obtained.
 - 5. Protect approved mockup, which will be used as a standard for remaining concrete stained work on the Project, until its removal is authorized. Remove mockup only after completion and final acceptance of colored concrete work.

1.05 HANDLING

- A. Delivery: Deliver materials to the Project site in original unopened containers clearly labeled with manufacturer's labels intact and legible indicating manufacturer's name, brand, type, source of product, date of manufacture, color designation and expiration date.
- B. Storage: Keep containers tightly closed and store away from direct sunlight, combustible materials and sources of heat. Rotate inventory.
- C. Handling:
 - 1. Handle products to avoid damage to container and contamination.
 - 2. Do not use products whose shelf life has expired.

1.06 PROJECT CONDITIONS

- A. Perform the work of this Section while ambient temperature is maintained within a range between 40- and 90-degree F during application.
- B. Do not apply concrete stain when no rain is forecast, nor under adverse weather conditions, or when temperature, humidity or other environmental requirements are beyond manufacturer's recommended limits.

PART 2 PRODUCTS

2.01 CONCRETE STAIN (SC-1)

- A. Manufacturer: LM Scofield (basis of design), Westcoast Specialized Coating Systems, H&C, or equal by McKinnon Materials, Inc.

2.02

- A. Products: Design is based on Formula One Liquid Dye Concentrate (Two Coats), Formula One Lithium Densifier (One Coat), Formula One Finish, Coat - Voc Free (One Coat).
- B. Items must conform to the following:
 - 1. Polishing method: Mechanical, Grade: 1 Cream Finish, Class: 2 Medium, 800 Grit.
 - 2. Color: < Insert >.

2.03 SEALER

- A. Sealer: Scofield "Selectseal," water-based acrylic/aliphatic urethane sealer, or Cureseal (matte) as selected by the Architect on the sample panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.

3.02 PREPARATION

- A. Protect adjacent surfaces from staining and damage by masking, covering them with impermeable coverings securely taped in place, or other appropriate form of protection, as required.
- B. Cleaning: Clean slab of foreign materials by scrubbing and rinsing with clear water. Protect and let dry.
 - 1. Ensure that concrete surface is clean, dry, structurally sound, and free from dirt, dust, oil, grease, solvents, paint, wax, asphalt, concrete curing compounds, sealing compounds, surface hardeners, bond breakers, adhesive residue, and other surface contaminants.
 - 2. Do not acid wash or use heavy alkali cleaners.

3.03 STAINING

- A. Apply stain full strength (undiluted) in accordance with its manufacturer's instructions at locations indicated.
- B. Control depth of color by adjusting volume of stain applied to floor.
- C. Apply 2 coats of stain. Allow floor to completely dry after each coat. Do not scrub clean between coats.
- D. After floor is completely dried, scrub off stain residue in accordance with the stain manufacturer's instructions. Allow floor to completely dry.
- E. Avoid washing concrete surfaces for a minimum of 48 hours.
- F. Protect stained surfaces; do not allow any traffic thereon until the sealer is applied, and then limit traffic to protected areas only.

3.04 POLISHING

- A. Refer to 03 35 29 "Retroplate."

3.05 SEALING

- A. Apply in accordance with its manufacturer's instructions to clean, dry concrete slabs. Finish shall be uniform, without sealer buildups, runs and holidays.

3.06 PROTECTING

- A. Unless otherwise recommended by the sealer manufacturer, restrict traffic on treated slabs for a minimum of 8 hours under normal conditions; protect traffic areas with dry, reinforced Kraft paper securely taped in place until final cleaning.
- B. Protect adjacent work from damages by this work with heavy Kraft paper or polyethylene film.
- C. Maintain protection in effective condition for as long as need for protection exists.
- D. Control use of water within the building so that no damage to previously installed work or existing improvements and finish occurs.
- E. Repair damaged areas to match adjacent, undamaged areas as approved by the Architect.
- F. Remove and replace damaged, stained, and other surfaces that do not match adjacent materials or cannot be satisfactorily cleaned or repaired, as determined and directed by the Architect, at no cost to the Owner.

END OF SECTION

SECTION 03 37 13

SHOTCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Pneumatically placed concrete.
- C. Related Sections:
 - 1. Section 03 2000: Concrete Reinforcement.
 - 2. Section 03 3000: Cast-In-Place Concrete.

1.02 SYSTEM DESCRIPTION

- A. Regulatory Requirements: Comply with CBC requirements, such as Section 1910A

1.03 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating locations to receive shotcrete. Provide details of installation and reinforcement.
- B. Product Data: Submit detailed product information identifying types and quality of materials, including admixtures.
- C. Submit a mix design of each proposed mix to be provided for the Work. If data from prior experience is not available or applicable, provide and perform specimen testing of proposed mix designs.

1.04 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement
 - 1. ACI 506.2 - Specification for Materials, Proportioning and Application of Shotcrete.
 - 2. ASTM C 150 - Portland Cement.
 - 3. Perform Work in accordance with ACI 506.2.
 - 4. Testing: Refer to DSA 103 and general notes on plans
- B. Qualifications of Installer:
- C. Mock-ups:

1. Test Panels: Construct a test panel of the thickness and reinforcing that reproduces the thickest and most congested area specified in the structural drawings. The IOR and special inspector will witness the assembly, reinforcing, installation, and disassembly of the test panel. The panel shall be at least 4 feet x 4 feet. After installation, but before the concrete has fully set, the panel shall be disassembled and inspected. The panel shall be free of voids, sags and defects.
2. Application of structural wet mix shotcrete in the finished Work shall not proceed until the test panel had been furnished, disassembled, and inspected by the IOR and special inspector.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Ensure materials and surrounding air temperature are a minimum 50 degrees F. prior to, during, and for at least 7 days after completion of Work.
- B. During freezing or near freezing weather, provide equipment and cover to maintain 50 degrees F. and to protect Work completed or in progress.
- C. Suspend installation during high winds, rainy weather, or near freezing temperature when Work cannot be protected.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: ASTM C 150 Type II/V or type L, low alkali.
- B. Aggregate: Conform to ACI 506, Gradation No. 1 or No. 2, ASTM C 33.
- C. Curing compound not detrimental to application of subsequent surface finish materials.

2.02 SHOTCRETE MIX

- A. Conform to following requirements:
 1. Compressive strength as indicated on Drawings; 28 day minimum.
 2. Aggregate size (maximum): 3/8 inch.
 3. Slump (plus or minus 1/2 inch): 1 inch to 2 inches
- B. Thoroughly mix shotcrete. Apply mix within 45 minutes.
- C. Develop mix design to provide compaction and low percentage of rebound, but stiff enough not to sag.
- D. Maintain quality control records during production of shotcrete. Submit records to the Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive shotcrete and verify unsuitable conditions have been corrected before proceeding. Verify that field conditions are acceptable and are ready to receive Work.

- B. Verify fabricated forms are true to line and dimension, adequately braced against vibration, and constructed to permit escape of air and rebound during installation.
- C. Ensure correct placement of reinforcement. Provide sufficient clearance around reinforcement to permit complete encasement.
- D. Provide safe access to shotcrete surfaces for screeding and finishing, to permit uninterrupted application.

3.02 PREPARATION

- A. Remove existing unsound concrete from substrate surfaces by chipping.
- B. Minimize abrupt changes in thickness of repair. Remove square external corners from substrate by rounding the edge.
- C. Sandblast existing surfaces that do not require chipping to remove oil, grease, and other contaminants, and to provide a roughed surface for proper bonding of the material.
- D. Determine operating procedures for placement in close quarter, extended distances, or around unusual obstructions where placement velocities and mix consistency must be adjusted.
- E. Clean and wet cementitious surfaces prior to installation. Maintain porous surfaces damp for several hours before installation. Do not install when there is visible free water present

3.03 BATCHING AND MIXING

- A. Shotcrete Mixes: Shall be designed based on the following minimum proportions:
 - 1. Provide shrinkage tests, as specified under Section 03 3000: Cast-In-Place Concrete.
 - 2. Provided mix with fine and 3/8 inch coarse aggregates shall contain between 20 and 30 percent pea gravel as specified, shotcrete-graded fine aggregate, at least 6.5 sacks of portland cement per cubic yard and sufficient water to produce a maximum slump of 2 inches plus-or-minus 1/2 inch.
 - 3. Shotcrete mixes shall be proportioned, batched and transported to assure complete mixing. Truck mixers shall be charged to not more than 75 percent of their rated capacity. Mixes shall be batched to provide a maximum 2 inch slump plus-or-minus 1/2 inch at the mixer at time of discharge. Water may be added at the Project site and in no case may the slump at the pump exceed 2 inches plus-or-minus 1/2 inch.
- B. Thoroughly mix cement and aggregate for at least one minute before adding water.

3.04 APPLICATION

- A. Install with suitable delivery equipment and procedures that will result in meeting the requirements of the Drawings and Specifications. Whenever possible, except when enclosing reinforcing steel, the nozzle shall be held at right angles to the surface to be placed and at a distance from 30 inches to 36 inches. When enclosing reinforcing steel, the nozzle shall be held so as to direct the material behind the bars. Each side of each bar shall be installed separately. Any deposits of loose sand or rebound shall be installed separately. Any deposits of loose sand or rebound shall be carefully removed from surfaces before material is installed. A second experienced nozzle operator equipped with an air jet shall attend the operators whenever reinforcing steel is being enclosed and shall carefully precede the nozzle and blow out rebound and sand which may have lodged behind the steel. Horizontal members shall not be installed from the top unless special methods are specified to eliminate rebound. The use of "puddled" shotcrete in which the water content of the mix is increased to facilitate the installation in difficult locations is not permitted. Shotcrete shall not be installed where the stream from the nozzle cannot directly impinge on the surface on which the shotcrete is to be installed.
- B. No rebound material shall be installed in the Work.
- C. The film of laitance, which forms on the surface of the shotcrete, shall be removed within approximately 2 hours after installation by brushing with a stiff broom. If this film is not removed within 2 hours, it shall be removed by wire brushing or sand blasting. Construction joints over 8 hours old shall be thoroughly cleaned before the installation of shotcrete.
- D. Damage: Pneumatically placed concrete subsiding after installation shall be removed and replaced. Rebound pockets, sags, sloughing or other defects shall be cut out and replaced.
- E. Surfaces to receive shotcrete shall have their entire surface thoroughly cleaned and roughened by sand blasting. Concrete and masonry shall be wetted before shotcrete is installed, but not so wet as to inhibit the installation. Sand for sand blasting shall be clean, sharp and uniform size, with no particles that will pass a 50 mesh screen.
- F. Reinforcement: Before installing shotcrete around or upon reinforcement, reinforcement shall be thoroughly cleaned of grease, oil, paint, loose mill scale, heavy rust and hydrated concrete.
- G. Reinforcing shall be supported and secured in place in such a manner that resulting vibrations from shotcrete installation will not damage and or dislodge reinforcing.
- H. Walls: Where structural wet mix shotcrete is to be installed to walls, minimum spacing of reinforcing steel shall be 6 bar diameters for walls with one curtain of steel. Where 2 curtains of steel are provided, curtain nearest nozzle shall be provided with a minimum spacing of 12 bar diameters and remaining curtain shall be provided with a minimum spacing of 6 bar diameters. Reinforcing steel shall be provided with a minimum of 3 bar diameters at splices. Minimum clear distance between reinforcing bars, other than mesh, shall be a minimum of 3 times maximum aggregate size.
1. Contact splices shall not be provided for bars larger than No. 5. Splices shall be non-contact back to back.
- I. Shotcrete forms shall be substantial and rigid. Forms shall be fabricated and installed to permit the effects of rebound.
1. Rigid or other required backing shall be installed against earth during application of wet mix shotcrete. Rigid or other required backing shall be provided where a void in embankment is to be bridged. Forms to be provided where required.

- J. Line and Thickness Control: Provide adequate wires or other required means to establish thickness, surface planes, and finish lines of shotcrete. Maintain specified tolerances by maintaining wires secure and taut.
- K. Placement Precautions: Do not install shotcrete if hydrating or stiffening of mix takes place at any time before delivery to nozzle.
- L. The height of a layer shall be limited to not more than 3 feet and a succeeding layer shall not be installed in less than 3 hours. Sloughing or sagging is not permitted.

3.05 FINISHING

- A. Install to a true, even surface by floating or rodding and providing a wood float finish to surfaces. Finish surfaces shall be within a tolerance of 1/8 inch in 10 feet. Finish to match existing conditions, if applicable.

3.06 CURING AND PROTECTING

- A. Initial Curing: Immediately after finishing, maintain shotcrete continuously moist for at least 20 days by one of the following materials or methods:
 - 1. Continuous sprinkling.
 - 2. Absorptive mat or other covering maintained continuously wet.
- B. Final Curing: Provide additional curing immediately following the initial curing and before shotcrete has hydrated with one of the following materials or methods:
 - 1. Continue the method provided for initial curing.
 - 2. Material conforming to ASTM C 171.
- C. Duration Of Curing. Maintain curing for the first 14 days after installation. During the curing period, maintain shotcrete above 40 degrees F. and in a moist condition as specified previously. Prevent rapid drying at end of curing period

3.07 FIELD QUALITY CONTROL

- A. Shotcrete Work shall be continuously inspected during installation. A special inspector, approved by DSA to inspect the Work of this section, shall inspect the materials, placing equipment, details of construction, and construction procedure. The IOR shall be responsible for monitoring the work of the special inspector and testing laboratories to ensure that the testing program is satisfactorily completed.
- B. No less than 2 cores each day shall be obtained from the Work at locations designated by the special inspector. At least one core shall be obtained for each 50 cubic yards of shotcrete. Cores shall be tested at approximately 28 days. Cores shall be 4 inches in diameter or larger. In addition, cores shall be obtained from 2 test panels each day. Test panels must be correlated with locations of wall being installed at same time as test panels.
- C. The special inspector shall observe coring operations and will prepare a report of coring operations for the testing laboratory.
- D. Obtain representative core samples in accordance with CBC recommendations, and test in accordance with ASTM C 42.

- E. Remove and replace shotcrete which lacks uniformity, exhibits segregation, honeycombing, or lamination, or which contains any dry patches, slugs, voids, or sand pockets.
- F. Remove and replace damaged shotcrete, which cannot be satisfactorily repaired.
- G. Repair core holes in accordance with Chapter 9 of ACI 301. Do not fill core holes with shotcrete. Repair holes with non-shrink non-staining concrete.

3.08 PROTECTION

- A. Before installation, protect interior and exterior trim, sash, doors, transoms, floors, ceilings and equipment. Debris shall be immediately cleaned up after installation but not less than once each day.
- B. Protect the Work of this section until Substantial Completion.

3.09 CLEAN-UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 03 38 00
POST-TENSIONED CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
1. Furnishing post-tensioning reinforcement and accessories including encapsulated prestressing tendons, pocket formers, support bars, bar chairs, and slab bolsters.
 2. Installing post-tensioning tendons.
 3. Performing post-tensioning operations including stressing and finishing tendons.
 4. Recording tendon elongations and gage pressures.
 5. Finishing tendon ends and patching stressing pockets.
- B. Related Sections include the following:
1. Division 3 Section "Cast-in-Place Concrete" for cast-in-place concrete.
 2. Division 3 Section "Concrete Reinforcement" for placement of nonprestressed steel reinforcement.
 3. Division 3 Section "Concrete Formwork" for formwork and forming accessories.
 4. Architectural Concrete

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 DEFINITIONS

- A. Strand Tail: Excess strand length extending past the anchorage device.
- B. Stressing Blockout: Opening created in the slab to allow access to stressing-end anchorages.
- C. Stressing Pocket: Void formed by pocket former at stressing-end anchorage to provide required cover over wedges and strand tail.
- D. Wedge Cavity: Cone-shaped hole in anchorage device designed to hold the wedges that anchor the strand.

1.04 SUBMITTALS

- A. Product Data: For the following:
1. Post-tensioning coating.
 2. Tendon sheathing.

3. Anchorage devices.
 4. Tendon couplers.
 5. Bar and tendon supports.
 6. Pocket formers.
 7. Sheathing repair tape.
 8. Stressing-pocket patching material.
 9. Encapsulation system.
- B. Shop Drawings: Installation drawings including plans, elevations, sections, details, and notes prepared by or under the supervision of a registered professional engineer detailing tendon layout and installation procedures, including the following:
1. Numbers, arrangement, and designation of post-tensioning tendons.
 2. Tendon profiles and method of tendon support including chair heights and locations. Show tendon profiles at sufficient scale to clearly indicate all support points, with their associated heights.
 3. Construction joint locations, pour sequence, locations of anchorages and blockouts required for stressing.
 4. Stressing procedures and jacking force to result in final effective forces used in determining number of tendons required.
 5. Sealed calculations prepared by a California registered professional engineer indicating method of elongation calculation including values used for friction coefficients, anchorage seating loss, elastic shortening, creep, relaxation, and shrinkage.
 6. Calculated elongations for each tendon.
 7. Details for horizontal curvature around openings and at anchorages.
 8. Details for corners and other locations where tendon layouts may conflict with one another or nonprestressed reinforcing steel.
 9. Diagrams and notes as necessary for positioning of nonprestressed reinforcement required for installing post-tensioning tendons including, but not limited to, the following:
 - a. Support bars.
 - b. Backup bars and hairpins at anchorages.
 - c. Hairpins at locations of horizontal curvature.
 - d. Supplemental reinforcement at blockouts.
- C. Design Shop Drawings and calculations.
- D. Samples for Verification: For the following products:
1. Each anchorage device assembly with a minimum of 24 inches (610 mm) of coated, sheathed strand.
 - a. Include components of encapsulation system.
 2. Each coupler assembly with a minimum of 24 inches (610 mm) of coated, sheathed strand.
 - a. Include components of encapsulation system.
 3. All components of encapsulation system, unassembled and clearly marked as to usage.

- E. Product Certificates:
 - 1. For each type of anchorage device and coupler, signed by product manufacturer.
 - 2. For each type of encapsulation system, signed by product manufacturer.
- F. Qualification Data: For installer, manufacturer and testing agency. Include resume of individual supervising installation and stressing of post-tensioning tendons.
- G. Mill Test Reports: Certified mill test reports for prestressing strand used on Project indicating that strand is low-relaxation and including the following:
 - 1. Coil numbers or identification.
 - 2. Breaking load.
 - 3. Load at 1 percent extension.
 - 4. Elongation at failure.
 - 5. Modulus of elasticity.
 - 6. Diameter and net area of strand.
- H. Field quality-control test reports.
- I. Procedures Statement: Procedures for cutting excess strand tail and patching stressing pocket.
- J. Stressing Jack Calibration: Calibration certificates for jacks and gages to be used on Project. Calibrate each jack-and-gage set as a pair. Calibration certificates shall be 6 months old or less.
- K. Stressing Records: Filled out by testing agency during stressing operation with the following information recorded:
 - 1. Name of Project.
 - 2. Date of approved installation drawings used for installation and stressing.
 - 3. Floor number and concrete placement area.
 - 4. Date of stressing operation.
 - 5. Weather conditions including temperature and rainfall.
 - 6. Name and signature of inspector.
 - 7. Name of individual in charge of stressing operation.
 - 8. Serial or identification numbers of jack and gage.
 - 9. Date of jack-and-gage calibration certificates.
 - 10. Gage pressure to achieve required stressing force per supplied calibration chart.
 - 11. Tendon identification mark.
 - 12. Calculated tendon elongation.
 - 13. Actual tendon elongation.
 - 14. Actual gage pressure.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 - Field Fundamentals course or has equivalent verifiable experience and knowledge acceptable to Architect.
 - 1. Superintendent must have received training from post-tensioning supplier in the operation of stressing equipment to be used on Project.
- B. Manufacturer Qualifications: Fabricating plant certified by PTI according to procedures set forth in PTI's "Manual for Certification of Plants Producing Unbonded Single Strand Tendons."
- C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Testing Agency Inspector: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 - Field Fundamentals course or shall have equivalent qualifications acceptable to Architect.
- D. Source Limitations: Obtain post-tensioning materials and equipment from the same supplier.
 - 1. Stressing jacks not provided by post-tensioning supplier must be calibrated and approved for use on Project by post-tensioning supplier.
- E. ACI Publications: Comply with ACI 423.6, "Specification for Unbonded Single Strand Tendons," unless otherwise indicated in the Contract Documents.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to installation and stressing of post-tensioning tendons including, but not limited to, the following:
 - 1. Construction schedule and availability of materials, personnel, and equipment needed to make progress and avoid delays.
 - 2. Storage of post-tensioning materials on-site.
 - 3. Structural load limitations.
 - 4. Coordination of post-tensioning installation drawings and nonprestressed reinforcing steel placing drawings.
 - 5. Horizontal and vertical tolerances on tendon and nonprestressed reinforcement placement.
 - 6. Marking and measuring of elongations.
 - 7. Submittal of stressing records and requirements for tendon finishing.
 - 8. Removal of formwork.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle post-tensioning materials according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
- B. Inspect tendons and accessory items at time of their delivery to Project site, prior to off-loading. Notify post-tensioning supplier of observed damage prior to off-loading.
- C. Keep accurate and current records of materials delivered and used.
- D. Immediately remove from Project site any tendons with damaged strand.

1.07 COORDINATION

A. Attachments and Penetrations:

1. Attach permanent fixtures such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the slab using embedded anchors. Drilled anchors are not allowed unless authorized in writing by Architect.
2. Power-driven fasteners are not allowed unless authorized in writing by Architect.
3. Core drilling for sleeves or other penetrations is not allowed unless authorized in writing by Architect.
4. Protect penetrations within 18 inches of an anchorage with ASTM A 53/A 53M, Schedule 40 steel pipe.

PART 2 PRODUCTS

2.01 PRESTRESSING TENDONS

- A. Prestressing Strand: ASTM A 416, Grade 270, uncoated, 7-wire, low-relaxation, 0.5-inch diameter strand.
- B. Post-Tensioning Coating: Compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties specified in ACI 423.6; chemically stable and nonreactive with prestressing steel, nonprestressed reinforcement, sheathing material, and concrete.
 1. Minimum Coating Weight: 2.5 lb for 0.5-inch per 100 feet (30 m) of strand.
 2. Completely fill annular space between strand and sheathing over entire tendon length with post-tensioning coating.
- C. Tendon Sheathing: Comply with ACI 423.6.
 1. Minimum Thickness: 0.050 inch for polyethylene or polypropylene with a minimum density of 0.034 lb/cu. in.
 2. Continuous over the entire length of tendon to provide watertight encapsulation of strand and between anchorages to prevent intrusion of cement paste or loss of coating for a non-encapsulated system.
- D. Anchorage Device and Coupler Assembly: Assembly of strand, wedges, and anchorage device or coupler complying with static and fatigue testing requirements in ACI 423.6 and capable of developing 95 percent of actual breaking strength of strand.
 1. Anchorage Bearing Stresses: Comply with ACI 423.6 for stresses at transfer load and service load.
 2. Fixed-End Anchorage Device Assemblies: Plant fabricated with wedges seated at a load of not less than 80 percent and not more than 85 percent of breaking strength of strand.
- E. Encapsulation System: Watertight encapsulation of prestressing strand consisting of the following:
 1. Wedge-Cavity Caps: Attached to anchorages with a positive mechanical connection and completely filled with post-tensioning coating.
 - a. Caps for Fixed and Stressing-End Anchorages Devices: Designed to provide watertight encapsulation of wedge cavity. Sized to allow required extension of strand past the wedges.

- 1) Attach cap for fixed-end anchorage device in fabricating plant.
- b. Caps at Intermediate Anchorages: Open to allow passage of strand.
2. Sleeves: Attached to anchorage device with positive mechanical connection; overlapped a minimum of 4 inches (100 mm) with sheathing and completely filled with post-tensioning coating.

2.02 NONPRESTRESSED STEEL BARS

- A. Support Bars, Reinforcing Bars, Hairpins: ASTM A 706, Grade 60, deformed. Minimum support bar size is 1/2 inch.
- B. Low-Alloy-Steel Support Bars, Reinforcing Bars, Hairpins: ASTM A 706, deformed.
- C. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 1. For uncoated bars, use all-plastic CRSI Class 1 plastic-protected bar supports.

2.03 ACCESSORIES

- A. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.
- B. Anchorage Fasteners: Galvanized steel nails, wires, and screws used to attach anchorage devices to formwork.
- C. Sheathing Repair Tape: Elastic, self-adhesive, moistureproof tape with minimum width of 2 inches (50 mm), in contrasting color to tendon sheathing; nonreactive with sheathing, coating, or prestressing steel.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Adhesive Tape Products, Inc.; PWT-20.
 - b. 3M; Tape 226.
 - c. Tyco Adhesives; Polyken 826, or equal.

2.04 PATCHING MATERIAL

- A. Patching Material: One component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead application. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Euclid Chemical Company (The); Verticoat Supreme.
 - b. Fox Industries, Inc.; FX-228.

- c. Kaufman Products, Inc.; Patchwell Kit HB.
- d. Master Builders, Inc.; Emaco R350 CI.
- e. Sika Corporation, Inc.; SikaMonoTop 612 or equal.

PART 3 EXECUTION

3.01 FORMWORK

- A. Provide formwork for post-tensioned elements as specified in Division 3 Section "Cast-in-Place Concrete." Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.
- B. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations have been approved by Architect, unless authorized in writing by Architect.
- C. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations have been approved by Architect, unless authorized in writing by Architect.

3.02 NONPRESTRESSED STEEL REINFORCEMENT PLACEMENT

- A. Placement of nonprestressed steel reinforcement is specified in Division 3 Section "Cast-in-Place Concrete." Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

3.03 TENDON INSTALLATION

- A. Install tendons according to approved installation drawings and procedures stated in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
- B. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of 42 inches o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.
 - 1. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding 48 inches. Ensure that tendon profiles between high and low points are smooth parabolic curves.
 - 2. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
 - 3. Support slab tendons independent of beam reinforcement.
- C. Maintain tendon profile within maximum allowable deviations from design profile as follows:
 - 1. 1/4 inch for member depth less than or equal to 8 inches.
 - 2. 3/8 inch for member depth greater than 8 inches and less than or equal to 24 inches.
 - 3. 1/2 inch for member depth greater than 24 inches.
- D. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of 2 inches of separation between tendons at locations of curvature.

- E. Limit tendon bundles to five tendons. Do not twist or entwine tendons within a bundle. Maintain a minimum distance of 12 inches between center of adjacent bundles.
- F. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs unless changes are authorized in writing by Architect. Obtain Architect's approval before relocating tendons or tendon anchorages that interfere with one another.
- G. Deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts.
- H. Installation of Anchorage Devices:
 - 1. Place anchorage devices at locations shown on approved installation drawings.
 - 2. Do not switch fixed and stressing-end anchorage locations unless authorized in writing by Architect.
 - 3. Attach pocket formers, intermediate anchorage devices, and stressing-end anchorage devices securely to bulkhead forms. Install stressing-end and intermediate anchorage devices perpendicular to tendon axis.
 - 4. Install tendons straight, without vertical or horizontal curvature, for a minimum of 12 inches (300 mm) behind stressing-end and intermediate anchorages.
 - 5. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.
 - 6. Minimum splice length in reinforcing bars at anchorages is 24 inches. Stagger splices a minimum of 60 inches.
 - 7. Place fixed-end anchorage devices in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.
 - 8. Retain subparagraph below if an encapsulated system is specified. Revise as necessary if an encapsulated system is specified only for certain portions of structure.
 - 9. Remove loose caps on fixed-end anchorages, refill with post-tensioning coating, and re-attach caps to achieve a watertight enclosure.
- I. Maintain minimum concrete cover as follows:
 - 1. From Exterior Edge of Concrete to Wedge Cavity: 1-1/2 inches.
 - 2. Retain subparagraph below if a non-encapsulated system is specified. Revise as necessary if an encapsulated system is specified only for certain portions of structure.
 - 3. From Exterior Edge of Concrete to Strand Tail: 3/4 inch.
 - 4. Retain subparagraph below if an encapsulated system is specified. Revise as necessary if an encapsulated system is specified only for certain portions of structure.
 - 5. From Exterior Edge of Concrete to Wedge-Cavity Cap: 1 inch.
 - 6. A minimum of 1-inch (25-mm) top and edge concrete cover is recommended for anchorage devices in aggressive environments.
 - 7. Top, Bottom, and Edge Cover for Anchorage Devices: 1-1/2 inches.
- J. Maintain minimum clearance of 6 inches between tendons and openings.
- K. Paint markings on formwork will be transferred to concrete, allowing tendon locations to be determined by examination of slab soffit. Delete first paragraph below or use alternate method of marking tendon locations if soffit is to be exposed or such markings are not desired.

- L. Prior to concrete placement, mark tendon locations on formwork with spray paint.
- M. Do not install sleeves within 36 inches of anchorages after tendon layout has been inspected unless authorized in writing by Architect.
- N. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected unless authorized in writing by Architect.
- O. Do not use couplers unless location has been approved by Architect.

3.04 SHEATHING INSPECTION AND REPAIR

- A. Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring post-tensioning coating and repairing or replacing tendon sheathing.
 - 1. Ensure that sheathing is watertight and there are no air voids.
 - 2. Follow tape repair procedures in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."
- B. Maximum length of exposed strand behind anchorages is as follows:
 - 1. Fixed End: 12 inches.
 - 2. Intermediate and Stressing End: 1 inch.
 - a. Cover exposed strand with sheathing repair tape to prevent contact with concrete.
- C. Immediately remove and replace tendons that have damaged strand.

3.05 CONCRETE PLACEMENT

- A. Do not place concrete until placement of tendons and nonprestressed steel reinforcement has been inspected by special inspector and Structural Engineer.
- B. Provide Architect and special inspector and Structural Engineer a minimum of 48 hours' notice before concrete placement.
- C. Place concrete as specified in Division 3 Section "Cast-in-Place Concrete." Ensure compaction of concrete around anchorages.
- D. Ensure that position of tendon and nonprestressed steel reinforcement does not change during concrete placement. Reposition tendons and nonprestressed steel reinforcement moved during concrete placement.
- E. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete placing equipment on tendons.

3.06 TENDON STRESSING

- A. Calibrate stressing jacks and gages at least every six months. Keep copies of calibration certificates for each jack-and-gage pair on Project site and available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.
- B. Stress tendons only under supervision of qualified post-tensioning superintendent.
- C. Do not begin stressing operations until concrete strength has reached 3000 psi as indicated by compression tests of field-cured cylinders.

- D. If concrete has not reached required strength within 96 hours, obtain Architect's approval to partially stress tendons and delay final stressing until concrete has reached required strength.
- E. Retain first paragraph below if stage stressing will be required; revise to suit Project.
- F. Stage stress transfer girders according to schedule shown on the Contract Drawings.
- G. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.
- H. Mark and measure elongations according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons." Measure elongations to closest 1/8 inch.
- I. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies to satisfaction of Architect.
- J. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.
- K. If measured elongations deviate from calculated elongations by more than 7 percent, additional testing, restressing, strengthening, or replacement of affected elements may be required.

3.07 TENDON FINISHING

- A. Do not cut strand tails or cover anchorages until stressing records have been reviewed and approved by Architect.
- B. Cut strand tails as soon as possible after approval of elongations.
- C. Cut strand tail between 1/2 and 3/4 inch from wedges. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include the following:
 - 1. Oxyacetylene flame.
 - 2. Abrasive wheel.
 - 3. Hydraulic shears.
 - 4. Plasma cutting.
- D. Install caps and sleeves on intermediate anchorages within one day of stressing.
- E. Cut strand tails and install caps on stressing-end anchorages within one day of Structural Engineer's acceptance of elongations.
- F. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of pocket to remove laitance or post-tensioning coating before installing patch material. Finish patch material flush with adjacent concrete.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports. Cooperate with testing agency to facilitate the execution of its duties.

1. Before concrete placement, testing agency will inspect the following for compliance with post-tensioning installation drawings and the Contract Documents:
 - a. Location and number of tendons.
 - b. Tendon profiles and cover.
 - c. Installation of backup bars, hairpins, and other nonprestressed reinforcement shown on post-tensioning installation drawings.
 - d. Installation of pocket formers and anchorage devices.
 - e. Repair of damaged sheathing.
 - f. Connections between sheathing and anchorage devices.
2. Testing agency will record tendon elongations during stressing.
3. Testing agency will immediately report deviations from the Contract Documents to Architect.

3.09 PROTECTION

- A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade component.
- B. Protect exposed components within one workday of their exposure during installation.
- C. Prevent water from entering tendons during installation and stressing.
- D. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.10 REPAIRS

- A. Submit repair procedure to Architect for evaluation and approval.
- B. Do not proceed with repairs requiring removal of concrete unless authorized in writing by Architect.

END OF SECTION

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SECTION 03 45 00

ARCHITECTURAL PRECAST CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
1. Precast architectural concrete units.
 2. Mold materials.
 3. Reinforcing materials.
 4. Prestressing tendons.
 5. Concrete materials.
 6. Steel connection materials.
 7. Stainless steel connection materials.
 8. Accessories.
 9. Grout materials.
 10. Clay facing materials.
 11. Stone facing materials.
 12. Insulated panel materials.
 13. Architectural precast concrete wall cap units.
 14. Concrete stair treads

1.02 DEFINITIONS

- A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, pre-approved by Architect.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural performance: Provide architectural precast concrete units and connections capable of withstanding design loads within limits and under conditions indicated.

1.04 SUBMITTALS

- A. Product data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years or period of warranty, whichever is greater.
- B. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate member locations, plans, elevations, dimensions, shapes and cross sections
1. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
 2. Indicate relationship of architectural precast concrete units to adjacent materials.

- C. Samples: Design reference samples for initial verification of design intent, approximately 12 by 12 by 2 inches (300 by 300 by 50 mm), representative of finishes, color, and textures of exposed surfaces of architectural precast concrete units.
 - 1. When back face of precast concrete unit is to be exposed, show samples of the workmanship, color, and texture of the backup concrete as well as the facing.
- D. Samples for each brick unit required, showing the full range of color and texture expected. Supply sketch of each corner or special shape with dimensions. Supply sample showing color and texture of joint treatment.
- E. Welding certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.
- F. Qualification data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- G. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
- H. Material certificates: Signed by manufacturers certifying that each of the following items complies with requirements.
 - 1. Concrete materials.

1.05 QUALITY ASSURANCE

1.06 HANDLING

- A. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, staining, and to prevent cracking, distortion, warping or other physical damage.
- B. Store units, unless otherwise specified, with non-staining, resilient supports.
- C. Place stored units so identification marks are clearly visible, and product can be inspected.
- D. Deliver all architectural precast concrete units to the project site in such quantities and at such times to assure compliance with the agreed project schedule and proper setting sequence so as to limit unloading units temporarily on the ground.
- E. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.
- F. Place non-staining resilient spacers of even thickness between each unit.
- G. Support units during shipment on non-staining shock absorbing material.

1.07 SEQUENCING

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 PRODUCTS

2.01 FABRICATORS

- A. Available fabricators: Subject to compliance with requirements, fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Fabricators: Subject to compliance with requirements, provide products by one of the following:
 - 1. <Insert fabricators' names and product designations for acceptable manufacturers.>

2.02 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; non-reactive with concrete and suitable for producing required finishes.
 - 1. Mold-release agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
- B. Form Liners: Units of face design, texture, arrangement, and configuration [indicated] [to match precast concrete design reference sample]. Provide solid backing and form supports to ensure that form liners remain in place during concrete placement. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
- C. Surface retarder: Chemical set retarder capable of temporarily delaying hardening of newly placed concrete mix to depth of reveal specified.

2.03 REINFORCING MATERIALS

- A. Reinforcing bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-alloy-steel reinforcing bars: ASTM A 706/A 706M, deformed.
- C. Galvanized reinforcing bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized and chromate wash treated after fabrication and bending, as follows:
 - 1. Steel reinforcement: **[ASTM A 615/A 615M, Grade 60 (Grade 420)] [ASTM A 706/A 706M]**, deformed.
- D. Epoxy-coated reinforcing bars: ASTM A 775/A 775M or ASTM A 934/A 934M, as follows:
 - 1. Steel reinforcement: **[ASTM A 615/A 615M, Grade 60 (Grade 420)] [ASTM A 706/A 706M]**, deformed.
- E. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips, as follows:
 - 1. Steel reinforcement: **[ASTM A 615/A 615M, Grade 60 (Grade 420)] [ASTM A 706/A 706M]**, deformed bars.
- F. Plain-steel welded wire reinforcement: ASTM A 185, fabricated from **[as-drawn] [galvanized and chromate wash treated]** steel wire into flat sheets.
- G. Deformed-steel welded wire reinforcement: ASTM A 497, flat sheet.

- H. Epoxy-coated-steel welded wire reinforcement: ASTM A 884/A 884M Class A coated, [plain] [deformed], flat sheet, [Type 1 bendable coating] [Type 2 non-bendable coating].
- I. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.04 CONCRETE MATERIALS

- A. Portland cement: ASTM C150, Type I or III.
 - 1. For surfaces exposed to view in finished structure, use [gray] [and] [white], same type, brand, and mill source throughout the precast concrete production.
 - 2. Standard gray Portland cement may be used for non-exposed backup concrete.
- B. Supplementary cementitious materials.
 - 1. Fly ash admixture: ASTM C 618, Class C or F with maximum loss on ignition of 3 percent.
 - 2. Metakaolin admixture: ASTM C 618, Class N.
 - 3. Silica fume admixture: ASTM C 1240 with optional chemical and physical requirement.
 - 4. Ground granulated blast-furnace slag: ASTM C989, Grade 100 or 120.
- C. Normal-weight aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Provide and stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for entire project.
 - 1. Face-mix coarse aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - a. Gradation: [Uniformly graded] [Gap graded] [To match design reference sample].
 - 2. Face-mix fine aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Architect.
- D. Backup concrete aggregates: ASTM C33 or C330.
- E. Lightweight aggregates: Except as modified by PCI MNL 117, ASTM C 330 with absorption less than 11 percent.
- F. Coloring admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable and non-fading.
- G. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- H. Air-entraining admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- I. Water-reducing admixture: ASTM C 494/C494M, Type A.
- J. Retarding admixture: ASTM C 494/C494M, Type B.
- K. Water-reducing and retarding admixture: ASTM C 494/C494M, Type D.
- L. High-range, water-reducing admixture: ASTM C 494/C494M, Type F.

- M. High-range, water-reducing and retarding admixture: ASTM C 494/C494M, Type G.
- N. Plasticizing admixture for flowable Concrete: ASTM C 1017/C1017M.
- O. Admixtures containing calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture are not permitted.

2.05 GROUT MATERIALS

- A. Sand-cement grout: Portland cement complying with ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404. Mix at ratio of one part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, non-shrink grout: Premixed, nonmetallic, non-corrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of a consistency suitable for application within a 30-minute working time.
- C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C881 of type, grade, and class to suit requirements.

2.06 CONCRETE MIXES

- A. Prepare design mixes to match Architect's sample for each type of concrete required.
 - 1. Limit use of fly ash and granulated blast-furnace slag to 20 percent replacement of Portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
- B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.
- D. Normal-weight concrete face and backup mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on project, to provide normal-weight concrete with the following properties:
 - 1. Compressive strength (28 Days): 5000 psi (34.5 MPa).
 - 2. Maximum water-cementitious materials ratio: 0.45.
- E. Water absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
- F. Lightweight concrete backup mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
 - 1. Compressive strength (28 Days): 5000 psi (34.5 MPa).
 - 2. Unit weight: Calculated equilibrium unit weight of 115 lb/cu.-foot (1842 kg/cu.m), plus or minus 3 lb/cu.-foot (48 kg/cu.m), according to ASTM C 567.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

- H. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.07 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement and vibration operations and temperature changes [and for prestressing and detensioning operations]. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
 - 1. [Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during placing of concrete. Coat form liner with form-release agent.]
- B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
 - 1. Form joints are not permitted on faces exposed to view in the finished work.
 - 2. Edge and corner treatment: Uniformly **[chamfered]** **[radiused]**.

2.08 FABRICATION

- A. Cast-in anchors, inserts, plates, angles, and other anchorage hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
- B. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4, "Recommended Practices for Stud Welding."
- C. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- D. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on contract drawing.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.
 - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy coated reinforcing exceeds limits specified ASTM A775/A775M repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete- placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
 - 3. Place reinforcing steel and prestressing strand to maintain at least 3/4 -inch (19 mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses.
- G. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.
- H. Place face mix to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover as indicated on contract drawings.
 1. At the fabricator's option either of the following mix design/casting techniques may be used:
 - a. A single design mix throughout the entire thickness of panel.
 - b. Design mixes for facing and backup; using cement and aggregates for each type as indicated, for consecutive placement in the mold. Use cement and aggregate specified for facing mix, use cement and aggregate for backup mix complying with criteria specified as selected by the fabricator.
- I. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.
 1. Place backup concrete to ensure bond with face mix concrete.
- J. Thoroughly consolidate placed concrete by internal and/or external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.
 1. Place self-consolidating concrete without vibration in accordance with PCI Interim Guidelines for the Use of Self-Consolidating Concrete.
- K. Comply with ACI 306.1 procedures for cold-weather concrete placement.
- L. Comply with ACI 305R recommendations for hot-weather concrete placement.
- M. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that will not show in finished structure.
- N. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until the compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of the final product.
- O. Repair damaged architectural precast concrete units to meet acceptability requirements of PCI MNL 117.

2.09 FINISHES

- A. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved [design reference sample] [sample panels] [mockups] and as follows:
1. Design reference sample: <Insert description and identify fabricator and code number of sample.>
 2. PCI's "Architectural Precast Concrete –Color and Texture Selection Guide," of plate numbers indicated.
 3. As-cast surface finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs.
 4. Textured-surface finish: Impart by form liners to provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
 5. Bush hammer finish: Use power and hand tools to remove matrix and fracture coarse aggregates.
 6. Exposed aggregate finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
 7. Abrasive-blast finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 8. Acid-etched finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections and insulation from acid attack.
 9. Honed finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 10. Polished finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 11. Sand-embedment finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
- B. Finish exposed [top] [bottom] [back] surfaces of architectural precast concrete units to match face-surface finish.
- C. Finish unexposed surfaces [top] [bottom] [and back] of architectural precast concrete units by smooth steel-trowel finish.
- D. Finish unexposed surfaces of architectural precast concrete units by float finish.

2.10 SOURCE QUALITY CONTROL

- A. Quality-control testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete also test and inspect according to PCI Interim Guidelines for the Use of Self-Consolidating Concrete.
- B. Owner will employ an independent testing agency to verify architectural precast concrete fabricator's quality-control and testing methods.
1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

- C. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
- D. Testing: If there is evidence that the concrete strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, Precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C42M.
1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect.
 2. Cores will be tested in an air-dry condition.
 3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
 4. Test results will be made in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete units or units represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Defective work: Architectural precast concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range are unacceptable. Chipped, spalled or cracked units may be repaired, if repaired units match the visual mock-up. The Architect reserves the right to reject any unit if it does not match the accepted samples and visual mock-up. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 EXECUTION

3.01 PREPARATION

- A. Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work.
- B. Provide locations, setting diagrams, and templates for the proper installation of each anchorage device.

3.02 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance
- B. Do not install precast concrete units until supporting cast-in place concrete building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast.
- C. Correct unsatisfactory conditions before proceeding with installation.

3.03 ERECTION

- A. Erect precast concrete level, plumb and square within the specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
 - 1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
 - 4. Unless otherwise shown provide for uniform joint widths of 3/4 inch (19mm)
- B. Connect precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
 - 1. Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.
- C. Grouting connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.04 ERECTION TOLERANCES

- A. Erect architectural precast concrete units level, plumb, square, true, and in alignment without exceeding the non-cumulative erection tolerances of PCI MNL 117, Appendix I.
- B. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.
- C. Field welds will be subject to visual inspections and non-destructive testing in accordance with ASTM E 165 or ASTM E 709.
- D. Testing agency will report test results promptly and in writing to Contractor and Architect.
- E. Repair or remove and replace work that does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS

- A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged architectural precast concrete units when repairs do not meet requirements.

3.06 CLEANING

- A. Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.
- B. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

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SECTION 03 54 00

SELF-LEVELING PORTLAND CEMENT BASED UNDERLAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fluid-applied self-leveling floor underlayment.

1.02 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) 2021.
- B. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars 2021.

1.03 SUBMITTALS

- A. Data: Manufacturer Product Data for product proposed for use.
- B. Tests: Test results as specified below.
- C. Sample panel:
 - 1. Provide, on a floor slab at the job site, a 10-foot square Sample panel of the cementitious underlayment to demonstrate texture of finish surface and test levelness of finish assembly.
 - 2. Make such modifications as necessary to achieve a Sample panel satisfactory to the Architect, or remove and construct additional Sample panel(s).
 - 3. Approved Sample panel may remain in place shall serve as the standard for the same work on the building.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the work of this Section.
 - 1. Approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for combustibility or flame spread requirements.

1.07 FIELD CONDITIONS

- A. Do not use in exterior applications.

- B. Do not apply where exposed to prolonged contact with water.
- C. Do not install underlayment until floor penetrations and peripheral work are complete.
- D. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during and 72 hours after installation of underlayment.
- E. During the curing process, ventilate spaces to remove excess moisture.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cast Underlayments: General:
 - 1. Comply with applicable code for combustibility or flame spread requirements.
 - 2. Provide certificate of compliance from authority having jurisdiction indicating approval of underlayment materials in the required fire rated assembly.
- B. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment with the following properties:
 - 1. Compressive Strength: Minimum 4000 psi after 28 days, tested per ASTM C109/C109M.
 - 2. Flexural Strength: Minimum 1250 psi after 28 days, tested per ASTM C348.
 - 3. Density: 125 lb/cu ft, nominal.
 - 4. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch.
- C. Primer: Manufacturer's recommended type.
- D. Sealer: Manufacturer's proprietary overspray material, formulated to seal cured floor surfaces to receive subsequent adhered finishes.
- E. Entangled net sound mat laminated to a point bonded moisture resistant fabric.
 - 1. Sound Control Mat: ASTM E 84; polymer, random geometric patterned core.

2.02 MIXING

- A. Site mix materials in accordance with manufacturer's instructions.
- B. Add aggregate, if recommended or required by manufacturer, for areas where thickness will exceed 1 inch. Mix underlayment and water for at least two minutes before adding aggregate, and continue mixing to assure that aggregate has been thoroughly coated.
- C. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION

3.01 EXAMINATION/PREPARATION

- A. Verify conditions affecting the work of this Section at the site.

- B. Correct detrimental conditions before proceeding with installation.

3.02 SURFACE PREPARATION

- A. Ensure the concrete floor substrate has fully achieved designed compressive strength.
- B. Repair subfloor with concrete repair products 24 hours prior to application of floor topping.
- C. Fill all non-moving, dry cracks with a low viscosity epoxy immediately prior to application of the floor topping.
- D. Perform surface preparation in accordance with standard ACI recommendations.
- E. Perform light, mechanical abrading of the existing substrate to remove all unsound concrete, contaminates, coatings, and adhesives.
- F. Ensure substrate is structurally sound, rigid, dust-free, and free of any contaminants that will adversely affect the bond of the floor topping. Concrete floors should have fully achieved designed compressive strength.
- G. Determine the moisture content and water vapor transmission rate of the subfloor prior to application of floor topping.

3.03 APPLICATION

- A. Install underlayment in accordance with manufacturer's instructions.
- B. Priming:
 - 1. Prime the properly prepared substrate with manufacturer's recommended primer to ensure maximum adhesion of floor topping.
- C. General: Mix and apply underlayment components according to manufacturer's written instructions.
 - 1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
 - 2. Coordinate application of components to provide optimum adhesion to substrate and between coats.
 - 3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
- D. Install screeds as recommended by manufacturer and as required to meet tolerance specified below. Set screeds with a laser level.
 - 1. Set screeds so that the minimum thickness of underlayment will be at least 1/8 inch.
 - 2. Where underlayment covers only a small area, grind, chisel and undercut slab, if required, so that the minimum thickness will not be less than 1/8 inch.
- E. Pump or pour material onto substrate. Do not retemper or add water.
 - 1. Pump, move, and screed while the material is still highly flowable.
 - 2. Be careful not to create cold joints.
 - 3. Wear spiked shoes while working in the wet material to avoid leaving marks.

- F. Place to indicated thickness, with top surface level to 1/16 inch in 10 ft.
 - 1. For final thickness over 1-1/2 inches, place underlayment in layers. Allow initial layer to harden to the point where the material has lost its evaporative moisture. Immediately prime and begin application of the subsequent layer within 24 hours.
- G. Place after partition installation.
- H. Where additional aggregate has been used in the mix, add a top layer of neat mix (without aggregate), if needed to level and smooth the surface.
- I. Transition from locations where sound reduction mat is installed to primary floor surface elevation; use transition strip or other recommended means to create straight and uniform transitions between carpet and resilient flooring areas where such condition is indicated on Drawings. Coordinate finished underlayment surface elevations with flooring thicknesses, door openings, and required clearances.

3.04 CURING

- A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
- B. Air cure in accordance with manufacturer's instructions.
- C. Apply sealer to cured flooring surfaces scheduled to receive adhered and glued-down finishes.
- D. Seal damaged floor surfaces, regardless of scheduled finish, in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field inspection and testing, as specified in Section 01 4000 - Quality Requirements.
- B. Placed Material: Agency will inspect and test for conformance to specified requirements.

END OF SECTION

DIVISION 04

MASONRY

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SECTION 04 21 30

ADHERED THIN BRICK VENEER

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Thin brick veneer.
 - 2. Skim coat, weather barrier, mortar for brick masonry.
- B. Work supplied by other Sections but installed by this Section:
 - 1. Section 07 27 26 for Fluid-Applied Membrane Air Barrier.
 - 2. Section 07 62 00 for Sheet metal flashing.

1.02 PREINSTALLATION MEETING

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 SUBMITTALS

- A. Product Data: Copies of manufacturer's printed specifications, installation instructions and general recommendations for all materials specified.
- B. Samples:
 - 1. Three samples of each type, shape and size of brick. Include in each set the full range of exposed color and texture to be expected in the finish Work.
 - 2. Full size Samples of 6-inch long samples of each type concealed flashing and neoprene pad.
- C. Shop drawings:
 - 1. Building elevations where brickwork occurs identifying all brick shapes and sizes. Large scale isometric Shop Drawings for all brick sizes and shapes other than "standard."
 - 2. Large scale, dimensioned Shop Drawings for flashings identifying materials, gauge(s), and showing details of fabrication, methods of lapping, joining and fastening, and other pertinent data. For conditions difficult to illustrate in 2-dimension, furnish isometric drawings.
- D. Material Certificates: For each type and size of the following:
 - 1. Masonry units:
 - a. Include data on material properties material test reports substantiating compliance with requirements.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C67.

- d. For Clay Face Brick: Facing brick complying with ASTM C216.
2. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

1.04 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 1. Build mockups for typical exterior wall in sizes approximately 48 inches long by 72 inches high by full thickness, including face and accessories.
 - a. Include a sealant-filled joint at least 16 inches long in mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
 - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include skim coat, air barrier, flashing, and weep holes in exterior masonry-veneer wall mockup.
 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 4. Protect accepted mockups from the elements with weather-resistant membrane.
 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.05 HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 48 inches down face of veneer, and hold cover securely in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.02 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work.

2.03 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C216.
1. Manufacturer:
 - a. H. C. Muddox Co., basis of design.
 - b. Interstate Brick Co.
 - c. McNear Brick and Block.
 - d. Coronado Stone Products.
 - e. Or equal.
 2. Grade: SW.
 3. Type: FBX.
 4. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested according to ASTM C7.
 5. Efflorescence: Provide brick that has been tested according to ASTM C67 and is rated "not effloresced."
 6. Color: Match two existing sizes and colors on existing building.
 7. Brick Size: Norman and Standard: 1/2-inch thick maximum.

2.04 ACCESSORIES

- A. General:
1. System basis of design: Laticrete North American.
 2. Systems meeting these requirements by the following manufacturers are acceptable upon approval by Architect.:
 - a. Custom Builders Products.
 - b. Ardex.
 - c. Or equal.
 3. Do not change the source of materials which may affect the appearance of the finished brickwork after masonry has started.

4. Bricks shall be factory-blended to prevent unbalanced concentrations of colors in the Work.
 5. Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Skim coat over CMU: Laticrete Thin Brick Mortar.
- C. Waterproof Flashing Mortar: Laticrete Latapoxy Waterproof Flashing Mortar.
- D. Weather Barrier; See Section 07 27 26.
- E. Thin Set Adhesive: Laticrete MVIS Thin Brick Mortar.
- F. Pointing Mortar: Laticrete MVIS Masonry Pointing Mortar.
1. Color: As selected by Architect from manufacturer's standard palette of colors.
- G. Water used in mortar and grout: Taken from a supply distributed for domestic purposes and clean and free of acids, alkalies, or other organic materials at time of mixing.
- H. Sealant materials: As specified in Section 07 92 00.
- I. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
- J. Brick cleaner: Commercially prepared brick cleaning solution with a mild citric, acetic or sulfamic acid may be used when tests Samples provided by the Contractor are satisfactory to the Architect; do not use hydrofluoric, hydrochloric (muriatic) and ammonium bifluoride based acids.

PART 3 EXECUTION

3.01 EXAMINATION/PREPARATION

- A. Verify conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.
- C. Confirm that substrate deflection shall not exceed $l/240$ with system's added dead and live loads to substrate.
- D. Protect adjacent construction with appropriate means from mortar droppings and other effects of laying of brick masonry units.
- E. Foundations:
 1. Verify that the foundation is clean, rough and level. Sandblast the area under the masonry if the surface contains laitance or other foreign material or is not sufficiently rough.
 2. Verify that foundation elevation is such that the bed joint thickness will be between 1/4-inch and 3/4-inch. The foundation edge shall be true to line so that the masonry does not project over more than 1/4-inch.

3.02 SHORES AND CENTERING

- A. Design, erect, support, brace and maintain shoring and centering for temporary support of masonry elements.
- B. Construct true to required finished shape, size and form, well braced and made rigid in all parts and capable of supporting and sustaining the loads to which they are subjected.
- C. Leave shores and centering in place until masonry can safely carry its own weight and the added loads of construction.

3.03 INSTALLATION-GENERAL

- A. Do not use bricks with chips, cracks, voids, discolorations and other defects which might be visible or cause staining in the finished Work.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- D. Wherever possible, use full size units.
- E. Keep cutting to a minimum.
 - 1. Cut and fit bricks, including work required to accommodate the work of other trades, by saw cutting to produce straight, sharp edges without spalling or other defects.
- F. When being laid, the brick shall have suction sufficient to hold the mortar and to absorb water from the mortar and grout. The brick shall be sufficiently damp so that the mortar will remain plastic enough to permit the brick to be leveled and plumbed immediately after being laid without destroying bond.
- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

3.04 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2-inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet maximum.

3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. Match existing 1/2-inch joints.
2. Do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.05 SKIM COAT

- A. Install skim coat in accordance with ASTM C926.

3.06 INSTALLATION OF AIR BARRIER

- A. See Section 07 27 26.

3.07 LAYING THIN BRICK WALLS:

A. General:

1. Install in accordance with Thin Set Adhesive Manufacturer's recommendations.
2. Layout brickwork in advance for accurate spacing of exposed bond patterns with uniform joint widths, and to properly locate openings, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.
3. Install flashing at the perimeter of the openings, and weeps at the bottom of the walls and the perimeter of the openings to prevent the moisture from entering the building and to transmit the moisture to the outside of the wall. See Section 07 62 00.
4. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
5. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
6. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

7. Tool exposed joints slightly to match existing joints. Cut joints flush for masonry to be concealed. Rake out mortar where joints will receive sealant. Regardless of jointing specified, all jointing in masonry exposed to the weather shall be tooled, making solid, smooth, watertight compact joints.
8. Remove bricks disturbed after laying; clean and relay in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove bricks, clean off mortar, and reset in fresh mortar.
9. Install flashings where shown as masonry progresses. Form a watertight dam at concealed ends of flashing above and below openings whenever the flashing is interrupted. Lap joints 4-inch minimum and seal with sealant.
10. Do not apply more thin bed mortar than can be covered within 10-15 minutes, or while thin bed mortar is still wet and tacky.
11. Periodically, remove and check pieces of the thin brick veneer to verify 100% mortar coverage is being achieved.
12. Excess thin bed mortar must be cleaned from brick surfaces with a clean, wet cloth or sponge, while it is still fresh.
13. Allow the thin brick installation to set for 24 hours at 70° F, prior to pointing.

3.08 EXPANSION AND CONTROL JOINTS

- A. Provide control joints in brickwork where indicated on the Drawings and as specified below.
- B. Where brick comes in contact with the bottom of a shelf angle, install a continuous neoprene strip filler, in compliance with its manufacturer's printed instructions, to clean steel surfaces. Do not grout this joint but fill with sealant as specified below.
- C. In other control joints, insert preformed joint filler or back-up material in joints at proper depth to allow the correct cavity depth for the sealant.
 1. Make joint widths same as mortar joints.
 2. Keep joints open and clean by stuffing with polypropylene rope or other material to prevent filling with dirt, grout or mortar.
- D. After brick is grouted and completely dry, remove temporary filler material; brush joints clean and fill with the specified back-up material and sealant as specified in Section 07 92 00.

3.09 REPAIRING/POINTING

- A. Remove and replace bricks which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units.
- B. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- C. During the tooling of joints, enlarge voids or holes and completely fill with mortar or grout.

3.10 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

- B. Final Cleaning:
1. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 2. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 3. Clean bricks with specified cleaner using stiff bristle brushes in compliance with the cleaner manufacturer instructions.
- C. Coordinate cleaning with application of clear sealer specified in Section 09 90 00.

END OF SECTION

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SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of the General and Supplementary Conditions and Division 01 apply to this section.
- B. Section Includes:
 - 1. Concrete masonry units.
 - 2. Reinforcing steel.
 - 3. Mortar, grout and grouting.
 - 4. Bolts, anchors, hardware, metal frames, and other insert items.
- C. Related Sections:
 - 1. Section 01 42 00: Testing and Inspection.
 - 2. Section 03 10 00: Concrete Forms and Accessories.
 - 3. Section 03 20 00: Concrete Reinforcement.
 - 4. Section 03 30 00: Cast-In-Place Concrete.
 - 5. Section 05 12 00: Structural Steel.
 - 6. Section 08 11 00: Steel Doors and Frames.

1.02 REFERENCES:

- A. American Society for Testing and Materials International (ASTM):
 - 1. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
 - 2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - 3. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 4. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
 - 5. ASTM C150 - Standard Specification for Portland Cement.
 - 6. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
 - 7. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
 - 8. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
 - 9. ASTM C426 - Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.
 - 10. ASTM C476 - Standard Specification for Grout for Masonry.

11. ASTM C595 – Standard Specification for Blended Hydraulic Cements
 12. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 13. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
 14. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
 15. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
- B. Masonry Standards Joint Committee (MSJC):
1. ACI 530.1/ASCE6/TMS602 – Specification for Masonry Structures.
 2. ACI 530/ASCE5/TMS402 – Building Code Requirements for Masonry Structures.

1.03 SUBMITTALS

- A. Mix Design: Submit grout and mortar mix designs. Mix designs shall be signed and sealed by a Civil or Structural Engineer registered in the State of California.
- B. Product Data: Submit manufacturer's Product Data for assembly components, materials, and accessories. Submit certificates and data assuring that the proposed materials meet the specified ASTM standards.
- C. Samples: Submit Samples for each type of required masonry unit, including reinforcement and accessories.
- D. Shop Drawings: Indicate wall reinforcement, splice locations and bending diagrams.
- E. Admixtures: Additives and admixtures to mortar and grout shall not be used unless approved by the enforcing agency. Submit product data for any proposed admixture.
- F. LEED Documentation: Submit the following documentation
1. Specific product name, make, model, and manufacturer
 2. Material Cost
 3. Environmental Product Declaration (EPD) report:
 - a. Product-specific declaration: Manufacturer's Life Cycle Assessment conforming to ISO 14044
 - b. Product Specific Type III EPD with third-party Type III certification
 4. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.
 5. Extracted, Manufactured, and Purchased locally. Provide cutsheets, product literature or letter from the manufacturer indicating the location of extraction, manufacturing, and purchasing and distance from the project site.
 6. Health Product Declaration (HPD) with full disclosure of known hazards down to 1000ppm.

1.04 REGULATORY REQUIREMENTS

- A. Perform the Work in accordance with CBC, Chapter 21A.

- B. Comply with requirements of ACI 530.1.

1.05 QUALITY ASSURANCE

- A. Comply with the requirements of Specification Section 01420, CBC Chapter 21A, and ACI 530 and 530.1.
- B. Concrete Masonry Units:
 - 1. Notify the testing laboratory a minimum of 45 days in advance of installing concrete unit masonry, to allow for preconstruction testing of the units.
 - a. Units will be sampled and tested in accordance with ASTM C140 for compressive strength, absorption and moisture content.
 - b. Units will be sampled and tested in accordance with ASTM C426 for linear drying shrinkage.
 - 2. The material testing laboratory shall receive concrete masonry unit specimens for testing from masonry unit manufacturer. Number of specimens shall be as indicated in referenced ASTM standard tests. Testing laboratory will perform and send test results to the Architect and IOR.
- C. Cement: Submit certification from the cement manufacturer that the cement proposed for use on the project has been manufactured in accordance with ASTM C150 or ASTM C595. Certification shall include test results made on cement samples during production.
- D. Mortar and Grout Tests: At the beginning of all masonry work, mortar and grout will be tested in accordance with CBC Section 2105A.5.
 - 1. Mortar: Shall conform to ASTM C270 and to the property specifications of CBC Table 2103A.8(2) for Type S mortar.
 - a. Provide qualifications of mortar as meeting ASTM C270 at the beginning of the job and whenever mix design is changed.
 - b. Mortars will be evaluated during preconstruction, sampled and tested during construction for proportioning and compressive strength in accordance to ASTM C780 and ASTM C1586.
 - c. Tested mortar strength shall meet or exceed 900 psi at 7 days and 1,800 psi at 28 days.
 - 2. Grout: Shall conform to ASTM C476, and will be sampled and tested in accordance with ASTM C404 and ASTM C1019. Compressive strength shall equal or exceed specified compressive strength (f'_m) at 28 days, but not less than 2,000 psi.
 - a. Ready-Mix Grout: Grout manufacturer shall furnish batch ticket information in accordance to ASTM C94.
- E. Masonry Core Testing: Core testing will be performed in accordance with CBC, Section 2105A.4. Masonry removed by coring operations shall be replaced to match adjoining work.
- F. Inspection During Installation: A special inspector will continuously observe the installation of reinforced masonry. The IOR shall be responsible for monitoring the work of the special inspector and testing laboratories to ensure that the testing program is satisfactorily completed.
- G. The Owner will be responsible for the costs of original tests and inspection.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store units above grade on level platforms or pallets to allow air circulation under stacked units, in a dry location.
- B. Store cementitious materials and aggregates in such a manner as to prevent deterioration or intrusion of foreign matter or moisture.
- C. Handle units on pallets or flat bed barrows. Free discharge from conveyor units or transportation in mortar trays is not permitted.
- D. Cover and protect against wetting before installation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete Unit Masonry: Modular medium weight conforming to ASTM C90, grade N-1, hollow load-bearing concrete unit masonry. Minimum compressive strength of units shall be per structural drawings.
 - 1. Provide blocks by Orco, Angelus Block, or equal.
 - 2. Provide open-end units at walls to be grouted.
 - 3. Provide closed-end units at walls and at openings where ends will be exposed in finish Work; provide bond beam blocks where horizontal reinforcement is indicated.
 - 4. Provide special shapes and accessory units at locations indicated on Drawings.
 - 5. Provide units in colors and textures as indicated in the drawings.
 - 6. Masonry unit shall have been cured for a minimum of 28 days. Masonry unit shall have maximum liner shrinkage of 0.06 percent from saturated to oven dry.
- B. Cement: ASTM C150, Type II or ASTM C595 Type IL, from one source.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Aggregates: ASTM C144 for mortar and ASTM C404 for grout.
- E. Mortar: ASTM C270, Type S, conforming to the property specifications of CBC Table 2103A.8(2). Provide mortar color as indicated in the drawings.
- F. Grout: ASTM C476. Ready-mixed grout shall be manufactured and delivered to the jobsite in accordance to ASTM C94.
- G. Admixture for Grout: Grout Aid Type 2, as manufactured by Sika Chemical Corp., or equal.
- H. Water: Clean, potable, free from substances deleterious to mortar, grout or reinforcement.
- I. Reinforcing Steel: Provide and install reinforcing steel in accordance with Specification Section 03 20 00, Concrete Reinforcement.
- J. Cleaning Materials: Sure Klean No. 600 detergent by ProSoCo or equal.

- K. Miscellaneous Materials: As required to complete the Work.
- L. Anchor Bolts: Shall be hex headed bolts conforming to ASTM A307 Grade A with the dimensions of the hex head conforming to ANSI/ASME B18.2.1, unless noted otherwise on structural drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard units with cracks or other defects not complying with requirements of ASTM C 90.

3.02 CONSTRUCTION

- A. Construct per applicable provisions of CBC and ACI 530.1.
- B. Conform to ACI 530.1 for hot and cold weather masonry construction.

3.03 MORTAR AND GROUT MIXING

- A. Mortar: Shall provide a minimum strength of 1800 psi. Dry, loose volumes. Mix proportions will be verified by material testing laboratory.
- B. Grout: Shall provide a minimum strength of 2,000 psi or as indicated in the drawings, whichever is higher. Grout space requirements for coarse and fine grouts shall be per Table 7 of ACI 530.1. Add Sika Chemical Corp. Grout Aid or equal per manufacturer's instructions.
- C. Measurements: Proportion by accurate volume measurements. Measure in calibrated devices that can be checked at any time.
 - 1. Add water for workable consistency.
 - 2. Shovel measurements are not permitted.
- D. Mixing: Mix in accordance to ACI 530.1.
 - 1. Mortar: Place sand, cement, and water in mechanically operated mixer in that order, while mixer is running; mix for 3 minutes, add lime, and admixture (for grout), and continue mixing until a uniform mass is provided, but in no case less than 10 minutes. Measurement of ingredients shall be by volume. Mix dry ingredients with a sufficient amount of water to provide a workable mix. Batches of less than one sack of cement, and fractional sack batches are not permitted.
 - 2. Factory Blended Mortar: Mix in accordance with manufacturer's recommendations. Grout: Add sufficient water for a workable mix that will flow into all voids of the masonry without separation or segregation. Grout slump shall be between 8 and 11 inches.
- E. Re-tempering Time Limit: Use mortar within one hour after mixing. Discard any mortar that has been mixed longer or that has begun to set. If necessary re-temper within this time limit, by replacing only water lost due to evaporation and by thoroughly remixing.

3.04 INSTALLATION OF MASONRY UNITS

- A. Workmanship: Install masonry plumb and true to line with straight level joints of uniform thickness. Comply with ACI 530.1 tolerances. Maintain masonry clean during and after installation.
1. Lay-out and incorporate embedded hardware items.
 2. Assist other trades with built-in items, which require cutting and fitting of masonry.
 3. Cut block units with a diamond saw or carborundum wheel. Trowel or chisel cutting is not permitted.
 4. Keep cavities clear of droppings and debris. Remove droppings prior to grouting.
- B. Reinforcing Steel: Install as indicated on Drawings. Except as otherwise indicated, install reinforcement in accordance with standards of Concrete Reinforcing Steel Institute and to requirements specified in Specification Section 03 20 00, Concrete Reinforcement. Do not splice vertical reinforcement except where indicated on the Drawings.
- C. Shoring: Provide temporary shoring for lintels with sufficient strength to carry load without deflecting. Remove temporary shoring 28 days after masonry has been installed.
- D. Block Installation: Clean dirt and dust from surfaces before installation. Do not wet masonry units.
1. Foundation preparation: Sandblast tops of concrete starting surfaces, wash-off by high pressure water jet, and slurry coat surfaces with neat cement grout for bond to masonry.
 2. Install masonry with mortar to required joint thickness. Install blocks with 3/8-inch mortar bed on entire horizontal surface. Fill head joints solid, install tightly to adjoining units. Provide 3/8-inch joint thickness.
 - a. Hold racking to a minimum.
 - b. No tothing is permitted.
 - c. If it becomes necessary to move a unit after it has been installed, remove the unit, discard the mortar, and install the unit in fresh mortar.
 3. Anchor Bolts: Provide one-inch minimum grout space between bolts and masonry.
 4. Bond: Install units in stacked bond.
 5. Finish Joint Treatment: Unless otherwise indicated, cut both interior and exterior joints flush, and tool slightly concave to a dense, uniform surface.
 6. Grouting: Unless noted otherwise on Drawings, completely fill cells with grout.
- E. Steel Door Frames:
1. Locate door frames accurately, install plumb, "Ram-set" or "Rawlplug" to floor surface and brace in position before start of masonry installation.
 - a. Frames are specified to be furnished with adjustable anchors.
 - b. Fill interior of frames solid with mortar or grout as walls are constructed.
 2. Provide temporary wood spreaders from jamb to jamb and from head to floor to ensure that jambs do not bow-in, distort from a straight line, or deflect from superimposed loads during construction.

3.05 GROUTING

- A. Prior to grouting all cells shall be cleaned so that all spaces to be filled with grout do not contain mortar projections greater than 1/4 inch, loose mortar or foreign material.
- B. Grout materials and water contents shall be controlled to provide adequate fluidity for placement without segregation of the constituents, and shall be mixed thoroughly. Reinforcement shall be properly positioned and solidly embedded in the grout.
- C. The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour.
- D. Between grout pours, a horizontal control joint shall be formed by stopping all wythes at the same elevation and with the grout stopping at 1-1/2 inches below a mortar joint, except at the top of the wall. Where bond beams occur, the grout pour shall be stopped a minimum of 1/2 inch below the top of the masonry.

3.06 LOW-LIFT GROUTING FOR HOLLOW MASONRY UNITS

- A. Grouting shall meet the requirements of CBC Section 2104A.6.1.1.2.
- B. After mortar joints have set, cells are cleaned of mortar and debris, and reinforcement is installed and inspected, grout cells in 4 feet maximum lifts. Horizontal and vertical reinforcement shall be held in place by suitable devices.
- C. Grout may be installed by pump, tremie or bucket, using hoppers to avoid spilling on exposed surfaces.
- D. All grout shall be consolidated with a mechanical vibrator after placing so as to completely fill all voids and to consolidate the grout. Grouted walls shall be solid and without voids
- E. Units shall be laid a maximum of 4 feet before grouting, and all over-hanging mortar and mortar droppings shall be removed. Grouting shall follow each 4 feet of construction laid and shall be consolidated so as to completely fill all voids and embed all reinforcing steel. Stop grout pours 1-1/2 inches below top of each lift. When grouting is stopped for 1 hour or longer, horizontal construction joints shall be formed by stopping the pour of grout not less than 1/2 inch or more than 2 inches below the top of the uppermost unit grouted. Horizontal steel shall be fully embedded in grout in an uninterrupted pour.
- F. Place an initial 2 feet high lift around, thoroughly compact, then place balance of each lift, compacting again through total lift, with hardwood spading sticks or pencil vibrators.
- G. Remove and discard spilled grout from upper units before grout can harden.
- H. Bracing: Adequately brace walls against wind and other forces during and after construction.
- I. Re-puddle top of grout after initial set.
- J. Placement of reinforcement/bolts/embeds shall conform to CBC section 2104A.6.2.

3.07 HIGH-LIFT GROUTING OPTION FOR HOLLOW MASONRY UNITS

- A. Grouting shall meet the requirements of CBC Section 2104A.6.1.1.3 and DSA IR 21-2.

- B. High-lift grouting shall apply only to cell sizes available with 8 inch and wider block units. This method is limited to conditions where openings, block pattern arrangements, special reinforcing steel, or embedded structural steel details do not prevent the free flow of grout or inhibit the use of mechanical vibration.
- C. Provide bond beam units, inverted for start course, and omit alternate blocks or cut openings in alternate face shell on bottom course for cleanouts. Use of open-end concrete masonry units is preferred wherever possible and is required at stacked bond conditions. Cleanout openings shall be provided in every reinforced cell at the bottom of each pour of grout. Alternatively, if the course at the bottom of the pour is constructed entirely of inverted open-end bond beam units, cleanout openings need only be provided in every reinforced cell at the bottom of each pour of grout. Cleanouts shall be sealed before grouting.
- D. Remove projecting mortar fins. Wash out every cell thoroughly using a water jet, which has sufficient force to remove mortar from the interior of the cells, and from reinforcing steel. The foundation or other horizontal construction joints shall be cleaned of all loose material and mortar droppings before each pour.
- E. Plug each cleanout by setting a face shell in mortar into opening and securely bracing it in place to prevent displacement. If masonry is not exposed in finish Work, cleanouts may be formed.
- F. Grouting:
1. Grout masonry cells solid, free from voids, to top of wall in lifts not exceeding 4 feet in height. Horizontal intermediate construction joints are not permitted.
 2. Do not install grout until masonry has set a minimum of 3 days in warm weather (50 degrees to 85 degrees F.) or 5 days in cool, damp weather (35 degrees to 50 degrees F.).
 3. Pump grout into grout cell space as rapidly as practical. Discard grout not in place within one hour after water was first added to batch.
 4. Install grout with maximum slump without segregation. Place in a continuous pour, in maximum lifts of 4 feet, with approximately 30 to 60 minutes elapsed time between any 2 successive lifts under normal weather conditions. An approved admixture that reduces early water loss and produces an expansive action shall be used in the grout.
 5. Grout shall be consolidated in accordance with CBC section 2104A.6.2.
 6. An approved admixture that reduces early water loss and produces and expansive action shall be used in the grout.
- G. Consolidating:
1. Consolidate and reconsolidate grout using 3/4 inch lightweight flexible cable vibrators.
 2. First consolidation shall be performed to bottom of lift immediately after placement, and in case of subsequent lifts, through previously placed lift.
 3. Top lift shall be reconsolidated no sooner than 30 minutes after grout has been installed.
 4. Vibrating of reinforcing steel is not permitted.

- H. Bracing: Adequately brace walls against wind and other forces during and after construction.
- I. Placement of reinforcement/bolts/embeds shall conform to CBC section 2104A.6.2.
- J. Wall Ties: When stacked bond is used, or when adequate cross webs between face shells are not provided, heavy gage wire embedded in the horizontal mortar joints should be provided across continuous vertical joints or between face shells to prevent blowouts. External ties or braces may also be used for this purpose.
- K. Inspections and Testing: All masonry work is required to be continuously inspected during laying and grouting by an inspector specially approved for that purpose by DSA. Core tests shall be performed in accordance with DSA IR 21-2.

3.08 CURING

- A. Remove efflorescence, stains, debris, excess grout, and foreign matter.
- B. During curing, or for any other purpose, do not saturate masonry with water.
- C. For low-humidity conditions, dampen the wall surface with a very light fog spray continuously for 3 days to cure mortar in joints.

3.09 PARGE COAT

- A. Apply parge coat to the earth side of surfaces that are to receive waterproofing.
- B. A cement and sand mix (1:3.5 by volume) or Type S mortar may be used for the parge coat.
- C. Parging should be applied to damp (not saturated) concrete masonry in two 1/4 inch thick layers. The first coat should be roughened when partially set, hardened for 24 hours, and then moistened before second coat is applied. The second coat should be trowelled to a smooth, dense surface.
- D. The parge coat should be beveled at the top to form a wash, and thickened at the bottom to form a cove between the base of the wall and the top of footing.

3.10 CLEANING

- A. At completion of masonry Work, remove misplaced mortar, grout or other foreign substances, and clean surfaces which will be exposed in finish Work with specified cleaner, or with clean water and stiff fiber brushes.
- B. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.11 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

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SECTION 04 90 00
MASONRY CLEANING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes cleaning the following:

1. Unit masonry surfaces.
2. Stone surfaces.

1.03 ALLOWANCES

- A. Allowances for cleaning masonry are specified in Section 01 21 00 "Allowances."

1.04 DEFINITIONS

- A. Very Low-Pressure Spray: Under [100 psi] <Insert value>.
- B. Low-Pressure Spray: [100 to 400 psi; 4 to 6 gpm] <Insert range of values>.
- C. Medium-Pressure Spray: [400 to 800 psi; 4 to 6 gpm] <Insert range of values>.
- D. High-Pressure Spray: [800 to 1200 psi; 4 to 6 gpm] <Insert range of values>.

1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
 1. Review methods and procedures related to cleaning masonry including, but not limited to, the following:
 - a. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
 - b. Materials, material application, and sequencing.
 - c. Cleaning program.
 - d. Coordination with building occupants.

1.06 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform masonry-cleaning work in the following sequence:
 1. Remove plant growth.
 2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.

3. Remove paint.
4. Clean masonry surfaces.
5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Sections. Patch holes in mortar joints according to masonry repointing Sections.

1.07 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and application instructions.
2. Include test data substantiating that products comply with requirements.

1.08 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paint-remover manufacturer and chemical-cleaner manufacturer.

B. Preconstruction Test Reports: For cleaning materials and methods.

C. Cleaning program.

1.09 QUALITY ASSURANCE

A. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection [, preconstruction product testing,] and on-site assistance.

B. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection [, preconstruction product testing,] and on-site assistance.

C. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.

1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.

D. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Cleaning: Clean an area [approximately 25 sq. ft.] [as indicated] <Insert dimension> for each type of masonry and surface condition.
 - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
 - b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage one or more chemical-cleaner [and paint-remover] manufacturers to perform preconstruction testing on masonry surfaces.
 1. Use test areas as indicated and representative of proposed materials and existing construction.
 2. Propose changes to materials and methods to suit Project.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is 40 deg F and above and is predicted to remain so for at least seven days after completion of cleaning.

PART 2 PRODUCTS

2.01 PAINT REMOVERS

- A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.
- B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming, alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.
- C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation, for removing paint from masonry.
- D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation, for removing paint from masonry; containing no methanol or methylene chloride.
- E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation, for removing paint coatings from masonry; containing no methanol or methylene chloride.

2.02 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSP), 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

- D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.
- E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.
- F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
- G. Mild-Acid Cleaner: Manufacturer's standard mild-acid cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.
- H. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.
- I. One-Part Limestone Acidic Cleaner: Manufacturer's standard one-part acidic formulation for cleaning limestone.
- J. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium- or sodium-hydroxide-based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid.

2.03 ACCESSORY MATERIALS

- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

2.04 CHEMICAL CLEANING SOLUTIONS

- A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.
- B. Acidic Cleaner Solution for [Nonglazed Masonry] [and] [Unpolished Stone]: Dilute acidic cleaner with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by chemical-cleaner manufacturer.
 - 1. Stones: Use only on unpolished granite, unpolished dolomite marble, and siliceous sandstone.
- C. Acidic Cleaner for [Glazed Masonry] [and] [Polished Stone]: Dilute acidic cleaner with water to concentration demonstrated by testing that does not etch or otherwise damage glazed or polished surface, but not greater than that recommended in writing by chemical-cleaner manufacturer.
 - 1. Stones: Use only on polished granite and polished dolomite marble.

PART 3 EXECUTION

3.01 MASONRY-CLEANING SPECIALIST

- A. Masonry-Cleaning Specialist Firms: Subject to compliance with requirements, [provide masonry cleaning by one of the following] [firms that may provide masonry cleaning include, but are not limited to, the following]:

1. <Insert, in separate subparagraphs, names of masonry-cleaning specialist firms>.

3.02 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
 3. Neutralize alkaline and acid wastes before disposal.
 4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- B. Remove [gutters and] downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.
 1. Provide temporary rain drainage during work to direct water away from building.

3.03 CLEANING MASONRY, GENERAL

- A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from [20 feet] [50 feet] <Insert distance> away by Architect.
- B. Proceed with cleaning in an orderly manner; work from [bottom to top] [top to bottom] of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.
- C. Use only those cleaning methods indicated for each masonry material and location.
 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
 - a. Equip units with pressure gages.
 - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
 - f. For steam application, use steam generator capable of delivering live steam at nozzle.

- D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
- E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.
- F. Water Application Methods:
 - 1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- G. Steam Cleaning: Apply steam to masonry surfaces at the very low pressures indicated for each type of masonry. Hold nozzle at least 6 inches from masonry surface and apply steam in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- H. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush [or spray] application. [Do not spray apply at pressures exceeding 50 psi.] Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- I. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
 - 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
- J. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.04 PRELIMINARY CLEANING

- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.
- B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
 - 1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
 - 2. Remove paint and calking with [alkaline paint remover] <Insert requirement>.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Repeat application up to two times if needed.
 - 3. Remove asphalt and tar with [solvent-type paste paint remover] <Insert requirement>.
 - a. Comply with requirements in "Paint Removal" Article.

- b. Apply paint remover only to asphalt and tar by brush without prewetting.
- c. Allow paint remover to remain on surface for 10 to 30 minutes.
- d. Repeat application if needed.

3.05 PAINT REMOVAL <INSERT DRAWING DESIGNATION>

- A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- B. Paint Removal with Alkaline Paste Paint Remover:
 1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with brushes.
 3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
 5. Repeat process if necessary to remove all paint.
 6. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
 7. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
- C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
 1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
 3. Apply cover according to manufacturer's written instructions.
 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 5. Scrape off paint and remover.
 6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
 7. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
 8. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
 9. For spots of remaining paint, apply alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.
- D. Paint Removal with Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

E. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

3.06 CLEANING MASONRY <INSERT DRAWING DESIGNATION>

A. Cold-Water Soak:

1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles of [five minutes] <Insert time> on and [20 minutes] <Insert time> off.
4. Continue spraying [until surface encrustation has softened enough to permit its removal by water wash, as indicated by cleaning tests] [for 72 hours] <Insert requirement>.
5. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by [low] [medium] [high]-pressure spray.

C. Hot-Water Wash: Use hot water applied by [low] [medium] [high]-pressure spray.

D. Steam Cleaning: Apply steam at very low pressures not exceeding [30 psi] [80 psi] <Insert value>. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.

E. Detergent Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.

3. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

F. Mold, Mildew, and Algae Removal:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Apply mold, mildew, and algae remover by brush [or low-pressure spray].
3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

G. Nonacidic Gel Chemical Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Apply gel cleaner in 1/8-inch thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] <Insert requirement>.
4. Remove bulk of gel cleaner.
5. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

H. Nonacidic Liquid Chemical Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].
3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] <Insert requirement>.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

I. Mild-Acid Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].

3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] <Insert requirement>.
4. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

J. Acidic Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].
3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] <Insert requirement>.
4. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil. Rinse until all foaming, if any, stops and suds disappear.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

K. One-Part Limestone Chemical Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Apply cleaner to surface by brush [or low-pressure spray].
3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] <Insert requirement>.
4. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
5. Rinse with [cold] [hot] water applied by medium-pressure spray to remove chemicals and soil.

L. Two-Part Chemical Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.
2. Apply alkaline prewash cleaner to surface by brush or roller.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer unless otherwise indicated.
4. Rinse with [cold] [hot] water applied by medium-pressure spray to remove chemicals and soil.
5. Apply acidic afterwash cleaner to surface [in two applications], while surface is still wet, using [low-pressure spray equipment,] deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended in writing by manufacturer unless otherwise indicated.
6. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil. [Rinse until surface reaction value is between pH 5 and pH 9 according to pH-measuring paper, pen, or indicator solution.]
7. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once.

3.07 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage [paint-remover manufacturer's and] chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection [, to perform preconstruction product testing,] and provide on-site assistance when requested by Architect. Have [paint-remover manufacturer's and] chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than [once] [twice] <Insert requirement> to observing progress and quality of the work.

3.08 FINAL CLEANING

- A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
- B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION

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DIVISION 05

METALS

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SECTION 05 06 50

WELDED STUD CONNECTORS

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. This Section covers the technical requirements for welded stud connectors and forms a part of all other Sections which require stud connectors, anchor studs, stud shear connectors, and similar items to be provided in accordance with this Section.
 - 1. Section includes:
 - a. Welded shear stud connectors.
 - b. Welding equipment for attachment of steel studs.
 - 2. Related work:
 - a. Relevant sections of Division 05.

1.02 SYSTEM DESCRIPTION

- A. Provide steel shear studs for welding by automatically timed shear stud-welding equipment, complete with an arc shield (ferrule) of heat-resistant ceramic or equivalent for all studs, and for studs 5/16-inch diameter or larger, a deoxidizing and arc stabilizing flux.

1.03 SUBMITTALS

- A. Data: Submit shear stud manufacturer's product data, specifications, typical installation details and other data as necessary to demonstrate compliance with the specified requirements. Provide certified evidence stud bases are qualified in accordance with CBC. Provide copies of DSA approvals for all studs, stud bases, and arc shields.
- B. Samples: Submit full-size shear stud sample when requested by the Structural Engineer.
- C. Test reports:
 - 1. Submit current compliance report from International Code Council (ICC) Evaluation Services showing shear studs comply with the Drawings, Specifications and the requirements of the authorities having jurisdiction.
 - 2. Provide adequate test results to verify feasibility of through-deck welding for the particular connector sizes and deck thickness involved.
- D. Manufacturer's instructions: Submit manufacturer-prepared instructions concerning the proper surface preparation and installation shear studs.
 - 1. LEED Documentation: Submit the following documentation
 - a. Specific product name, make, model, and manufacturer
 - b. Material Cost

- c. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.
- d. Extracted, Manufactured, and Purchased locally. Provide cutsheets, product literature or letter from the manufacturer indicating the location of extraction, manufacturing, and purchasing and distance from the project site.

1.04 QUALITY ASSURANCE

- A. General: Furnish studs and stud bases currently qualified in accordance with CBC, AWS D1.1, latest revision, and install in accordance with the procedures and quality control requirements of AWS D1.1, latest revision. Employ welding mechanics that are skilled and experienced in installing required studs and currently qualified in accordance with AWS D1.1-15 and CBC Section 2204A.1.
- B. Welder's qualifications: Qualify welding operators and welding procedures in compliance with AWS "Qualification" requirements of AWS D1.1.
 - 1. Verify welders to be employed in this work have satisfactorily passed AWS qualification tests and are current in their certification.
 - 2. If re-certification is required, retesting will be Contractor's responsibility.
- C. Source Quality Control: Refer to Section 01 4100. Testing Laboratory shall test end welded studs furnished for either shop or field installation according to CBC Section, 2213A.2.

1.05 HANDLING

- A. Delivery: Deliver materials to project site in original unopened packages, clearly labeled with manufacturer's identification labels intact and legible, indicating manufacturer's name, brand, type and source of product.
 - 1. Storage: Store materials above ground and under cover.
 - 2. Handling: Protect materials from damage during shipping, handling, and storage at the site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of design is for "SL3" shear connectors fabricated by Nelson Stud Welding, Inc. Other acceptable materials/manufacturers include the following:
 - 1. "SC" shear connection studs by Stud Welding Associates.
 - 2. "Tru-Weld" shear connection studs by TFP Corporation.
 - 3. Or equal.

2.02 MATERIALS

- A. Steel: ASTM A 108, Grades C-1010 through C-1020 cold-drawn steel. Studs shall conform to the following minimum physical properties:
 - 1. Tensile strength: 65,000 psi.
 - 2. Yield strength: 51,000 psi.

3. Elongation in 2 inches: 20 percent.
 4. Reduction of area: 50 percent.
- B. Provide shear studs of uniform quality and condition, free of injurious laps, fins, seams, cracks, twists, bends not indicated, rust, rust pits, scale, oil and other injurious defects or substances.
1. Shear studs shall be finished by cold-heading, cold-rolling or machining.
 2. Shear studs shall not be painted, galvanized, or cadmium-plated prior to welding.

2.03 WELDING EQUIPMENT

- A. Furnish automatically timed stud-welding equipment and a suitable power source, of type and manufacturer listed as approved by the stud manufacturer. Interlock the welding equipment supplying current to two or more stud-welding guns so that only one gun can operate at a time and so power source has fully recovered from making one weld before another weld is started.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that galvanizing on steel deck does not exceed the zinc coating approved for stud installation. Report in writing all conditions that prevent or interfere with the proper installation of studs including loose steel decking or improper fitting.

3.02 PREPARATION

- A. Preparation shall conform to AWS D1.1-15.
- B. Surfaces to receive shear studs shall be free from oil, grease, waxy films, paint and other deleterious materials that would negatively affect the quality of installation, durability and performance of components.
- C. Promptly install shear studs after surface cleaning and preparation.
- D. Preparation for Replacement Studs and Repairs: Repair steel surfaces as follows wherever a defective stud is removed. Make area where a stud is removed flush and smooth if the surface remains exposed in the Work. Complete repairs before installing a replacement stud on a defect area.
1. Areas Subject To Tensile Stress: Make the area flush and smooth. If the base metal is pulled out by stud removal, fill pocket by shielded metal-arc welding conforming to AWS D1.1, latest revision, using low-hydrogen electrodes, and grind the weld surfaces flush.
 2. Areas Subject To Compression: Where any stud failures are confined to shanks or fusion zones of the studs, a new stud may be installed adjacent to the defective area in lieu of repairing defective area and installing a replacement stud, subject to approval. If metal is pulled out of base metal, fill pocket as specified above for tensile stress areas except, if the defect depth is not more than the lesser of 1/8" or 7% of base metal thickness, the defect may be faired by grinding in lieu of weld filling.

3.03 INSTALLATION

- A. Hold welding gun in correct position and without movement until the weld metal has solidified.
- B. Product welded studs free from any defect or substance that interferes with intended functions.
- C. Do not install shear studs that exhibit defects, rusting, rust pits, scale, oil, deleterious or other substances that will interfere with their intended function.
- D. Comply with shear stud manufacturer's instructions and the following.

1. Do not install studs on wet surfaces.
 2. Break and remove arc shield after welding.
- E. Shear stud lengths:
1. Shear stud lengths indicated are minimum net lengths after welding.
 2. If reduction in length of a stud as it is welded results in the length of the stud being more than 1/16-inch greater than length specified by stud manufacturer, discontinue installation until cause is determined and eliminated, and pre-production testing is satisfactorily repeated.
- F. Defective fillets: Shear studs not showing full 360-degree weld fillet after welding may be repaired by adding a 3/16-inch fillet weld, in lieu of the missing weld fillet, in compliance with AWS D1.1 using low-hydrogen electrodes.
- G. Singly space shear stud connectors along the beam with excess double studs spaced symmetrically from each end of the beam. Place adjacent studs on centers not closer than 3" transversely and not closer than 4-1/2" longitudinally, on centers. Provide minimum distance between edges of the shear stud bases and flange edges equal to the stud diameter plus 1/8", but minimum 1-1/2" clearance wherever possible. Location accuracy of other types of studs shall permit the assembly of attachments without alterations or reaming.

3.04 INSTALLATION THROUGH STEEL DECK

- A. Exercise caution to prevent defective welds or damage when welding through steel decking.
- B. When shear studs will be welded through steel deck or corrugated steel forming, top flange of beams to receive such studs shall be unpainted and free of debris prior to installation of the deck or forming.
1. Install deck or forming so that the bottom rib or plate is in continuous contact with the surface to receive the studs.
 2. Field-weld studs to structural members only after all steel framing, deck or forms are in place and shored where required.
- C. Weld shear connectors to supports through decking in compliance with shear connector manufacturer's instructions and AWS D1.1.
1. Weld only on clean dry deck surfaces.
 2. Use through-deck stud welding where deck material thickness permits proper weld fusion to develop required connector capacity.
 3. If through-deck stud welding is not feasible, install studs through pre-punched holes in the deck. Provide pre-punched holes only for the studs involved and keep hole oversize to the minimum required to develop a proper weld.
 4. Do not weld studs through 2 layers of deck heavier than 20-gage. Puddle welds (arc-spot) may be omitted where they coincide with studs.

3.05 SITE TOLERANCES

- A. Longitudinal and lateral spacing for shear stud connectors relative to each other and to edges of member flanges may vary 1-inch maximum from locations shown, provided adjacent studs are not closer than 2-1/2 inches O.C.
- B. Provide a minimum distance between edges of shear stud bases and member flange edges equal to the stud diameter plus 1/8-inch but minimum 1-1/2 in. clearance where possible.
- C. Location accuracy of other types of studs shall permit the assembly of attachments without alterations or reaming.

3.06 REPLACING DEFECTIVE STUDS

A. Where a defective stud is removed, repair steel surfaces as follows:
Where stud is removed, make areas flush and smooth.

Complete repairs before installing replacement stud in defective area.

B. Areas subject to tensile stress:

1. If base metal material is pulled-out by shear stud removal, fill pocket by shielded metal-arc welding using low-hydrogen electrodes in compliance with AWS D1.1
2. Grind the weld surfaces flush and smooth.

C. Areas subject to compression:

1. Where a shear stud failure is confined to the shanks or fusion zones of the stud, a new shear stud may be installed adjacent to the defective area, subject to the Structural Engineer's approval, in lieu of repairing the defective area and installing a replacement stud.
2. If base metal material is pulled out by shear stud removal, fill pocket as specified above for tensile areas, except that if defect depth is not more than the lesser of either 1/8-inch or 7 percent of the base metal thickness, the defect may be faired by grinding in lieu of weld filling.

3.07 FIELD QUALITY CONTROL

Inspection: In accordance with CBC Sections 2213A.2 and 2204A.1 perform shop and field welded stud installation and testing under continuous inspection of a qualified welding inspector approved by DSA. In addition to the verified report, welding inspector's reports shall detail the location of all defective studs with the repair or replacement action taken.

A. Site tests: The Owner will employ a testing agency to test installed shear studs for compliance with specified requirements.

1. Perform pre-production testing, and stud installation and production testing under continuous inspection by the Owner's testing agency.
2. In addition to the standard reports, testing agency reports shall detail the location of defective studs with repair or replacement action taken, damage resulting from stud installation, and all defects and unusual occurrences.

B. Inspection Procedure: In accordance with CBC Section 1705A.2 Welding equipment type and capacity shall be in accordance with manufacturer's recommendations and shall be checked and approved by the welding inspector. At beginning of each day's work, a minimum of two test studs shall be made with the equipment to be used to metal which is the same as the actual work piece. Test studs shall be subjected to 90 degree bend test by striking them with a heavy hammer; after this test, the weld section shall not exhibit any tearing out or cracking.

C. Pre-production testing: Perform the following tests with each welding equipment power source at the start of each production period, at the start of any new welding procedure, and after any change in welding procedure. Production period is defined as the time interval from start-up to any shutdown of any stud-welding equipment.

1. Shear stud connector test: After cooling, test first 2 shear studs on a member by hammer bending to a 45-degree angle.
 - a. If failure occurs in the weld zone of either shear stud, correct welding procedure, weld and bend test 2 more studs on the member.
 - b. If either of the second 2 shear studs fail, continue additional welding on separate materials until 2 consecutive studs are tested and found satisfactory before any more studs are welded to the member.

2. Studs other than shear connectors: Weld 2 studs to separate material in the same general position (flat, vertical, sloping or overhead) and similar steel material and thickness as members to receive studs.
 - a. After cooling, hammer-bend the studs to a 30-degree angle.
 - b. If failure occurs in the weld zone of either stud, correct the procedure and successfully weld and test 2 successive studs before any studs are welded to members.
 - D. Stud installation and production testing: After cooling, test at least one stud on each member by hammer bending to a 15-degree angle.
 1. If failure occurs either in the weld zone or stud shank, follow method of correction required above for pre-production testing until successful installations are produced. Replaced defective studs.
 2. Test all studs not showing a full 360-degree fillet weld, all replacement studs, any stud for which reduction in length is less than correct and any stud that has been repaired
 - a. After cooling, hammer-bend studs to a 15-degree angle.
 - b. For studs showing less than a 360-degree fillet weld, bend stud in the direction opposite to the missing weld fillet.
 - E. Inspection of studs other than shear connectors: Test at least one stud per 100 studs installed by hammer bending to a 15-degree angle
 1. If stud fails, correct the welding procedure as required above for pre-production testing and bend-test 2 more in-place studs.
 2. If either of the second 2 studs fail, all studs represented by the tests shall be bent-tested, or shall be rejected and replaced.
 3. The Structural Engineer shall designate the extent of additional inspection and testing for critical structural connections.
 - F. Remove and replace studs that crack in the weld zone, in the base metal or the shank either during inspection and testing or under subsequent straightening.
 - G. Straightening: Provided no portion of the stud will fall within one-inch of an exposed concrete surface, bent shear stud connectors and shear transfer devices that are less than 16 degrees from vertical and are free of failure may be left in the bent position.
 1. Perform stud bending and straightening without heating and before completion of each day's stud welding.
 2. Obtain inspection and approval of straightened studs before covering.
 - H. Load testing: Testing agency shall load test studs in the extent and by methods directed.
- 3.08 CLEANUP
- A. Leave areas around job site free of debris, welding materials, equipment and related items after completion of job.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Structural steel.
- C. Related Sections:
 - 1. Section 01 4100: Testing and Inspection.
 - 2. Section 03 3000: Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS, SPECIFICATIONS AND CODES

- A. CBC Chapter 22A.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC – Steel Construction Manual, 14th Edition, including:
 - a. AISC 360 Specifications for Structural Steel Buildings.
 - b. AISC 303 Code of Standard Practice for Steel Buildings and Bridges.
 - c. RCSC – Specification for Structural Joints Using ASTM A325 or A490 Bolts.
 - 2. AISC 341 - Seismic Provisions for Structural Steel Buildings, July 12, 2016
 - 3. AISC 358 - Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 4. ASTM A123 – Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - 5. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 6. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength.
 - 7. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 Ksi Minimum Tensile Strength.
 - 8. ASTM A435 - Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates.

9. ASTM A490 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
10. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
11. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
13. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. ASTM A673 - Standard Specification for Sampling Procedure for Impact Testing of Structural Steel,
15. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
16. ASTM A992 – Standard Specification for Structural Steel Shapes.
17. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).
18. ASTM E23 - Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.
19. ASTM E112 - Standard Test Methods for Determining Average Grain Size
20. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-Ksi Yield Strength.
21. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
22. ASTM F1852 – Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tension Strength.

D. American Welding Society (AWS):

1. AWS D1.1 – Structural Welding Code - Steel.
2. AWS D1.8 – Structural Welding Code – Seismic Supplement.
2. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
3. AWS B2.1 – Specifications for Welding Procedures and Performance Qualification.

E. SSPC – Steel Structures Painting Council:

1. SP-2 - Hand Tool Cleaning.

1.03 SYSTEM DESCRIPTION

A. Regulatory Requirements:

1. Structural steel shall conform to CBC requirements, except that steel manufactured by acid Bessemer process is not permitted for structural purposes.
2. Sheet and strip steel other than those listed in CBC, if provided for structural purpose, shall comply with DSA requirements.

1.04 SUBMITTALS

- A. Shop Drawings:
1. Submit Shop Drawings, including complete details and schedules for fabrication and shop assembly of members, and details, schedules, procedures and diagrams showing the sequence of erection. Fully detail minor connections and fastenings not shown or specified in the Contract Documents to meet required conditions using similar detailing as shown in the Contract Documents. Include a fully detailed, well controlled sequence and technique plan for shop and field welding that minimizes locked in stresses and distortion; submit sequence and technique plan for review by the Architect.
 - a. Include details of cuts, connections, camber, and holes in accordance with Figure 4.5 of AWS D1.1 or AISC 360 Section J1.8, weld position plan and other pertinent data. Indicate welds by standard AWS symbols, and show size, length and type of each weld.
 - b. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed for Work specified in other sections.
 - c. Erection and Bracing Plan and Erection Procedure: Submit an erection and framing plan, including columns, beams, and girders, signed and sealed by a Structural or Civil Engineer registered in the State of California in accordance with Title 8 CCR, Section 1710, Erection of Structures. Maintain a copy at the Project site as required by the California Division of Industrial Safety.
 - d. Submit a list of steel items to be galvanized.
 - e. Include identification and details of AESS members, if applicable.
- B. Product Data:
1. Submit copies of fabricator's specifications and installation instructions for the following products. Include laboratory test reports and other data required demonstrating compliance with these Specifications:
 - a. Structural steel, each type; including certified copies of mill reports covering chemical and physical properties.
 - b. Welding electrodes.
 - c. Welding gas.
 - d. Unfinished bolts and nuts.
 - e. Structural steel primer paint.
 - f. High-strength bolts, including nuts and washers.
- C. Manufacturer's Mill Certificate:
1. Submit, certifying that products meet or exceed specified requirements.
- D. Mill Test Reports:
1. Submit manufacturer's certificates, indicating structural yield and tensile strength, destructive and non-destructive test analysis.
- E. Submit certified copies of tests by manufacturer for fine grain practice. Structural steel base material, as described above, shall be manufactured to be fully killed and fine grained having grain size number 5 or better as determined by ASTM E112.

- F. Welding Procedure Specifications (WPS): Submit weld procedures for all welding on project to Owner's testing laboratory for approval. After approval by testing laboratory, submit to Architect of record for review. Weld procedures shall be qualified as described in AWS D1.5, section 5.12 or 5.13, AISC 341 and AISC 358, as applicable. Weld procedures shall indicate joints details and tolerances, preheat and interpass temperature, post-heat treatment, single or multiple stringer passes, peening of stringer passes for groove welds except for the first and the last pass, electrode type and size, welding current, polarity and amperes and root treatment. The welding variables for each stringer pass shall be recorded and averaged, from these averages the weld heat input shall be calculated. Submit the manufacturer's product data sheet for all welding material used. Welding shall not proceed until WPS have been reviewed and approved by the Engineer of Record.
- G. Welder's Certificates: Field welders shall be Project certified in accordance with AWS D1.1. Shop welders shall be Project certified for FCAW in accordance with AWS D1.1.
- H. Test Reports: Submit reports of tests conducted on shop and field welded and bolted connections. Include data on type of test conducted and test results.
- I. Welding Material Certification: Provide certificate that welding material complies to specifications. Submit to Owner's testing laboratory.
- J. LEED Documentation: Submit the following documentation
 1. Specific product name, make, model, and manufacturer
 2. Material Cost
 3. Environmental Product Declaration (EPD) report:
 4. Product-specific declaration: Manufacturer's Life Cycle Assessment conforming to ISO 14044
 5. Product Specific Type III EPD with third-party Type III certification
 6. Industry-wide (generic) EPD with third-party Type III certification
 7. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.
 8. Extracted, Manufactured, and Purchased locally. Provide cutsheets, product literature or letter from the manufacturer indicating the location of extraction, manufacturing, and purchasing and distance from the project site.
 9. Health Product Declaration (HPD) with full disclosure of known hazards down to 1000ppm.

1.05 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement, except as otherwise indicated:
 1. American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges", (AISC 303) modified as follows:
 - a. Replace "Structural Design Drawings" with "Contract Documents" throughout the document.
 - b. Paragraph 3.2 is hereby modified in it's entirety as follows:

- “Contract Documents including but not limited to architectural, mechanical, plumbing, electrical, civil and kitchen design drawings and specifications shall be used as supplement to the structural plans to define configurations and construction information.”
- c. Delete Paragraph 3.3.
 - d. In Paragraph 4.4, delete the following sentence:
“These drawings shall be returned to the Fabricator within 14 calendar days.”
 - e. Delete Paragraph 4.4.1.(a) in it’s entirety.
 - f. Paragraph 4.4.2 is hereby modified in it’s entirety as follows:
“No review action, implicit or explicit, shall be interpreted to authorize changes in the Contract Documents.”
2. AISC 360 - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings
 3. Perform welding in accordance with AWS Standards, AWS D1.1, and California Building Code Section 2204A.1 and approved Weld Procedure Specifications (WPS).
 4. California Building Code, 2019 Edition, Chapter 22A.
- B. Shop fabrication shall be inspected in accordance with CBC.
- C. Qualifications of Fabricator: Fabricate structural steel in shop of a licensed fabricator, AISC certified, in the same category of the scope of this project. City of Los Angeles certification in lieu of AISC certification is acceptable.
- D. Source Quality Control: Refer to Section 01 4100. Testing Laboratory shall perform conformance testing in accordance with CBC Section 2213A and 1705A.2.
1. Identified Structural Steel: Tests are waived for steel identified by heat number, accompanied by mill analyses and mill test reports, and properly tagged with an Identification Certificate so as to be readily identified for conformance with applicable ASTM. Comply with CBC Section, 1705A.2 and Table 1705A.2.1.
 2. Unidentified Structural Steel: Steel not identified and certified as specified above shall be tested according to following requirements. Structural steel fabricator shall cut samples under direction of the Special Inspector and Testing Laboratory shall machine or otherwise prepare the specimens and perform testing of each 5 tons or fraction thereof for each size of unidentified steel. In the case of random pieces or of steel having F_y greater than 36 Ksi, testing of each piece is required. Tests required are:
 - a. For pipe, one tension and elongation test and one flattening test for each size.
 - b. For all other steel, one tension and elongation test and one bend test for each size.
 - c. Contractor shall reimburse to Owner all costs paid by Owner for testing unidentified steel.
- E. Erection and Bracing Plan and Procedure: Refer to Section 1710, Title 8, CCR, and Building Code. Employ and pay a California registered civil engineer to prepare an erection and bracing plan and erection procedure for structural steel including columns, beams, and girders, who shall be solely responsible for its compliance. Follow the plan and procedure exactly. Keep a copy at the job site as required by California Division of Industrial Safety. File two copies of stamped erection and bracing plan and procedure for record purposes only, not for review or approval.

- F. Testing & Inspection shall comply with the following:
1. CBC Section 1705A Tests and Inspections of Structural Steel. All steel used for structural purposes shall be identified as required by CBC Section 2203A. Manufacturer's mill analyses and test reports are acceptable for properly identified steel, but the enforcement agency may require additional testing to determine the quality of the steel if there is any doubt as to its acceptability. Any steel not properly identified shall be tested to meet the minimum chemical and mechanical requirements of the ASTM standard appropriate for the steel specified for the structure.
 2. EXCEPTION: No mechanical tests are required for unidentified steel when the minimum yield stress required by the design is less than or equal to 25 ksi (172 Mpa) and the steel is not part of the designated lateral-force-resisting system. Contractor to verify applicability with engineer of record prior to exercising this exception to mechanical testing.
 3. CBC Section 1705A.2 Inspection of Shop Fabrication. Inspection of shop fabrication shall be required for significant structural detailed connection and fabrication work as directed by the enforcement agency. This inspection shall be made by a qualified inspector approved by the enforcement agency. The inspector shall furnish the architect, structural engineer and the enforcement agency with a report that the materials and workmanship conform to the approved plans and specifications.
 4. CBC Section 1705A.2 Inspection of Welding. Inspection of all shop and field welding operations, including the installation of automatic end-welded stud shear connectors shall be made by a qualified welding inspector approved by the enforcement agency. Such inspector shall be a person trained and thoroughly experienced in inspecting welding operations. The inspector's ability to distinguish between sound and unsound welding shall be reliably established. The minimum requirements for a qualified welding inspector shall be as those for an AWS certified welding inspector (CWI), as defined in the provisions of the ANSI/AWS QCI-1-96, Standard for AWS Certification of Welding Inspectors published by the American Welding Society. All welding inspectors shall be approved by the enforcement agency.
 5. The ability of each welder to produce sound welds of all types required by the work shall be established by welder qualification satisfactory to the enforcement agency.
 6. Welding inspection of structural welding shall conform to the requirements of AWS D1.1 Structural Welding Code – Steel, published by the American Welding Society, except as modified by this section.
 7. Welding inspection of cold-formed steel members shall conform to the requirements of AWS D1.3.
 8. The welding inspector shall make a systematic record of all welds. This record shall include in addition to other required records:
 - a. Identification marks of welders.
 - b. List of defective welds.
 - c. Manner of correction of defects.

9. The welding inspector shall check the material, equipment, details of construction and procedure, as well as the welds. The inspector shall also check the ability of the welder. The inspector shall verify that the installation procedure for automatic end-welded stud shear connectors is in accordance with the requirements of AWS D1.1, Structural Welding Code – Steel, published by the American Weld Society and the approved plans and specifications. The inspector shall furnish the architect, structural engineer and the enforcement agency with a verified report that the welding is proper and has been done in conformity with AWS D1.1, Structural Welding Code – Steel, published by the American Welding Society and the approved plans and specifications. The inspector shall use all means necessary to determine the quality of the weld. The inspector may use gamma ray, magnaflux, trepanning, sonics or any other aid to visual inspection, which the inspector may deem necessary to be assured of the adequacy of the welding.
10. Inspection and testing of high strength bolts (F3125), nuts and washers shall conform to the requirements found in CBC Table 1705A.2.1 and CBC Section 2213A.1.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store structural steel above grade on platforms, skids or other supports.
- B. Protect steel from corrosion.
- C. Store welding electrodes in accordance with AWS D 12.1. Deliver electrodes to the site in unbroken packages bearing the manufacturer's name and label identifying the contents.
- D. Store other materials in a weather-tight and dry place until installed into the Work.

1.07 PROJECT SITE CONDITIONS

- A. Site Measurements: Take field measurements as required. Report any major discrepancy between Drawings and field dimensions.
- B. Protection of Floors: Use caution to protect floor slab and adjacent Work from damage. Do not overload floors. Use rubber tired equipment to handle and move steel. Do not place steel members directly on floor; use pads of timber or like material for cushioning.
- C. Temporary Flooring: Provide necessary temporary planking, scaffolding, and flooring for erection of structural steel or support of erection machinery. Conform use of temporary floors or steel decking to Code.
- D. Connection of Steel Decking Temporary Flooring: Temporarily weld steel decking to supports where used as a working platform. Distribute concentrated loadings from welding machines and other heavy machinery with planking or equal. Replace decking damaged by use as a working platform at no additional contract cost.

PART 2 PRODUCTS

2.01 GENERAL

- A. Stock Materials: Provide exact materials, sections, shapes, thickness, sizes, weights, and details of construction indicated on Drawings. Changes because of material stock or shop practices will be considered if net area of shape or section is not reduced thereby, if material and structural properties are at least equivalent, and if overall dimensions are not exceeded.

- B. All shapes, bars, plates, tubes and pipes shall be made of materials with at least 16% recycled content if produced from Basic Oxygen Furnace (BOF) or at least 67% recycled content if produced from Electric Arc Furnace (EAF).

2.02 MATERIALS

- A. Structural Steel: See structural drawings for detailed list of steel shape ASTM designation requirements.
- B. Threaded Fasteners: See structural drawings for ASTM designations.
- C. High-Strength Threaded Fasteners: See structural drawings for ASTM designations.
- D. Anchor Bolts: See structural drawings for ASTM designations.
- E. Primer: Use types acceptable to governing air quality management officials.
 - 1. For above-grade locations: Lead free metal primer, Tnemec Uni-Bond DF Series 115 or Rust-Oleum X-60.
 - 2. For below grade applications: Coal-tar epoxy coating, two coats, 5 mils per coat. Perma Bar, as manufactured by Karlee Co., Burbank, CA, or equal. Touch-up on job site with Perma-Bar coal-tar epoxy, match finish coat thickness.
- F. Clevis & Turnbuckle materials to be C-1035 and shall have the capacity to resist loads equal to or greater than those specified in the Manual of Steel Construction – Allowable Stress Design, Ninth Edition Tables on 4-148 & 4-149. Supply Structural Engineer of Record evidence of conformance to the specified classifications and capacities.
- G. Galvanizing: ASTM A123.
- H. Welding Electrodes: Provide electrodes recommended by manufacturer for seismic connections.
 - 1. Comply with AISC 341.
 - 2. All electrodes shall have a minimum Notch-Toughness of 20 ft-lb at -20 degrees F.
- I. Grout: ASTM C1107, non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 7 days; of consistency suitable for application and a 30 minute working time. Grout shall be non-gas-forming, free of oxidizing catalysts and inorganic accelerators, performance and characteristics when mixed to a fluid consistency meeting CRD-C 79 and CRD-C 588, non-staining type in exposed areas.

2.03 FABRICATION

- A. Cleaning and Straightening Materials: Materials being fabricated shall be thoroughly cleaned of scale and rust, and straightened before fabrication. Cleaning and straightening methods shall not damage material. After punching or fabrication of component parts of a member, twists or bends shall be removed before parts are assembled. Produce finished members free from twists, bends, and open joints when erected.

- B. Drilling, Punching, and Reaming: Hole burning to make or enlarge previous holes is allowed only with prior approval. Prepare required holes in structural steel members for attachment or passage of Work of other trades. Precisely locate finished holes to ensure passage of all bolts through steel assemblies without drifting. Enlarge holes only by reaming. Poor matching of holes is cause for rejection.
- C. Milling: Compression joints depending on contact bearing shall be furnished with bearing surfaces prepared to a common plane by milling.
- D. Use of Burning Torch: Oxygen cutting of members shall be performed by machine. Gouges greater than 1/16 inch that remain from cutting shall be removed by grinding. Reentrant corners shall be shaped notch free to a radius of at least 1 inch. Gas cutting of holes for bolts or rivets is not permitted.
- E. Galvanizing: After fabrication, items indicated or specified to be galvanized shall be galvanized in largest practical sizes. Fabrication includes operations of shearing, punching, bending, forming, assembling or welding. Galvanized items shall be free from projections, barbs, or icicles resulting from the galvanizing process.
- F. Welding:
1. Type of steel furnished in welded structures shall provide chemical properties suitable for welding as determined by chemical analysis. Welds shall conform to the verification and inspection requirements of CBC Chapter 17A. Conform to AWS D1.1, and CBC Chapter 22A.
 2. Materials and workmanship shall conform to the requirements specified herein and to CBC requirements, modified as follows:
 - a. No welded splices shall be permitted except those indicated on Drawings unless specifically reviewed by the Architect.
 - b. Drawings will designate joints in which it is important that welding sequence and technique be controlled to minimize shrinkage stresses and distortion.
 3. Welding shall be performed in accordance with requirements of the AWS Structural Welding Code.
 - a. Welded Joint Details: Comply with AISC 341, AISC 358 and drawing details.
- G. Shop Finish:
1. Notify the IOR when Work is ready to receive shop prime coat. Work shall be inspected by the IOR before installation of primer.
 2. Structural steel and fittings, except galvanized items, which will be exposed when building is completed, shall receive a coat of primer.
 3. All exposed steel to receive Steel Coating System per section 099600.
Surface Preparation: [SSPC-SP1,2 or3] Commercial Blast Clean with a 2 mil angular anchor profile.
Prime Coat: Organic Urethane Zinc Rich conforms to SSPC Paint 20 type II and with the requirements of AISC "Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts" for a Class B Coating by testing method to determine the slip coefficient for coatings used in bolted connections. Products known to comply include the following.
Tnemec Company, Compton, CA: 90-97 Tneme-Zinc @ 2.5 to 3.5 mils DFT or equal
Tel # 310-639-9810

4. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete or high strength bolted.
 - H. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
 - I. Contact: Pin components parts of built-up members and maintain in close contact using clamps or temporary bolting during welding operations. Accurately mill compression bearing surfaces of joints depending on contact bearings or saw cut square to axis, or as detailed. Cut other joints straight and true.
 - J. Joining: Provide members of the sizes, weights, shapes, and arrangements indicated, closely fitted and finished true to line and in precise position as necessary to allow proper joining of parts in the field. Drifting to enlarge unfair holes is not allowed without prior approval.
 - K. Holes For Anchor Bolts: Punch and drill or ream holes in base and bearing plates. Do not make or enlarge the holes by burning except for grouting holes in column bases without prior approval by the Architect.
- 2.04 CONNECTIONS:
- A. Make connections with bolts as noted on the Structural Drawings.
- 2.05 WELDING:
- A. Conform to CBC Section 2240A.1, AWS D1.1 as modified by referenced AISC Standards, and as indicated or noted on Drawings. Employ welding operators qualified in accordance with AWS D1.1, as applicable, who are thoroughly trained and experienced in arc welding and that produce uniformly reliable groove and fillet welds in flat, vertical, and overhead positions, and make neat and consistent welds. Weld all structural steel joints by shielded electric-arc method unless otherwise shown, specified, or approved. Conform welding in both shop and field, including the prequalification of welds and welder qualifications, to AWS D1.1.
 - B. Storage and Care of Electrodes: Coatings of low-hydrogen type electrodes shall be thoroughly dry as used. Conform to AWS D1.1; use electrodes as taken from hermetically sealed packages within time limit specified therein after package is opened. Electrodes not used within allowable time period and electrodes that have been exposed more than one hour to air having a relative humidity of 75% or greater, or as required by the manufacturer, shall be dried according to AWS D1.1 before they are used, or shall be reconditioned according to electrode manufacturer's recommendations. Electrodes so dried or reconditioned not used within allowable time period after drying is completed shall be redried before use. Electrodes of any class that have been wet shall not be used under any conditions.
 - C. Preparation: Clean steel surfaces to be welded of all paint, grease, oil, mill scale, and foreign matter. Clean weld each time the electrode is changed. Chip full surface of hand guided and controlled flame cut edges before welding. Surfaces prepared with automatic or mechanically guided and controlled equipment need not be ground or chipped before welding.
 - D. Weld Finishing: Grind exposed welds subject to contact to smooth surfaces free of holes, slag, or other defects, flush with the adjoining surfaces. No finish treatment is required for permanently concealed welds and other exposed welds.

- E. Procedures: During assembling and welding, hold components of a built-up member with adequate clamps or other means to keep parts straight and in close contact. Do no welding in wind until adequate protective screening is set up. Cut out defective welds or parts of welds with a chisel or air arc and replace.
- F. Weld Characteristics: Conform to AWS D1.1, Chapter 8, Statically Loaded Structures. Clean and wire brush all welds. Visual inspection of finished welds must show uniform section, smoothness of welded metal, feather edges without undercuts or overlays, freedom from porosity and inclusions, and good fusion and penetration into base metal at edges and ends of fillet welds.

2.06 SHOP PRIMING

- A. Clean surfaces according to AISC Specifications. Apply one shop coat of specified metal primer to minimum 1.0 mil dry film thickness. Work primer into joints. Do not prime the following:
 - 1. Steel surfaces embedded in concrete or masonry with the exception of those steel surfaces that support anchored brick veneer.
 - 2. Contact surfaces of high-strength bolted connections or field welded connections.
 - 3. Surfaces to receive directly adhered fireproofing.

2.07 SHOP AND FIELD QUALITY CONTROL

- A. A special inspector, approved by DSA to inspect the Work of this section, shall inspect high-strength bolted connections. The Owner will provide a DSA approved independent testing laboratory to perform tests and prepare test reports in accordance with CBC 1704A.2.4. The IOR shall be responsible for monitoring the work of the special inspector and testing laboratories to ensure that the testing program is satisfactorily completed.
- B. An AWS CWI certified special inspector, approved by DSA to inspect the Work of this section, shall inspect welded connections in accordance with CBC 1705A.2.5. The Owner will provide a DSA approved independent testing laboratory to perform tests and prepare test reports. The IOR shall be responsible for monitoring the work of the special inspector and testing laboratories to ensure that the testing program is satisfactorily completed.
- C. The independent testing laboratory shall conduct and interpret test and state in each report whether test specimens comply with requirements, and specifically state any deviations there from.
- D. Provide access to all places where structural steel Work is being fabricated or produced so required inspection and testing can be performed.
- E. The independent testing laboratory may inspect and/or test structural steel at plant before shipment; however, Architect reserves the right at any time before Contract Completion to deem materials not in compliance with the specified requirements as defective Work.
- F. Correct defects in structural Work when inspections and laboratory test reports indicate noncompliance with specified requirements. Perform additional tests as may be required to reconfirm noncompliance of original Work, and as may be required to show demonstrate compliance of corrected Work.
- G. Welding: Inspect and test during fabrication and erection of structural steel assemblies as follows:

1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in the Work. Record Work required and performed to correct deficiencies.
 2. Inspect welds. Welds shall be visually inspected before performing any non-destructive testing. Groove weld shall be inspected by ultrasonic or other approved non-destructive test methods. Testing shall be performed to AWS D1.1 Table 6.2 statically loaded non-tubular connections.
 3. Ultrasonic testing shall be performed by a specially trained and qualified technician who shall operate the equipment, examine welds, and maintain a record of welds examined, defects found, and disposition of each defect. Repair and test defective welds.
 4. Rate of Testing: Completed welds contained in joints and splices shall be tested 100 percent either by ultrasonic testing or by radiography.
 5. Welds, when installed in column splices, shall be tested by either ultrasonic testing or radiography.
 6. Base metal thicker than 1-1/2 inches, when subjected to through-thickness weld shrinkage strains, shall be ultrasonically inspected by shear wave methods for discontinuities directly behind such welds. Tests shall be performed at least 48 hours after completed joint has cooled down to ambient air temperature.
 7. Any material discontinuities shall be reviewed based on the defect rating in accordance with the criteria of AWS D1.1 table 6.3 by the Architect and DSA.
 8. Other method of non-destructive testing and inspection, for example, liquid dye penetrate testing, magnetic particle inspection or radiographic inspection may be performed on weld if required.
 9. Lamellar Tearing: Lamellar-tearing resulting from welding is a crack (with zero tolerance) and shall be repaired in accordance with AWS D1.1.
 10. Lamination: The rejection criteria shall be based on ASTM A435.
 11. Where testing reveals lamination or conditions of lamellar tearing in base metal, the steel fabricator shall submit a proposed method of repair for review by the Architect. Test repaired areas as required.
 12. Magnetic Particle Testing: Magnetic particle testing when required shall be provided in accordance with AWS D1.1 for procedure and technique. The standards of acceptance shall be in accordance with AWS D1.1 – Qualification.
- H. Lamellar Tearing: Prior to welding plates 1 to 1-1/2 inches thick and greater and rolled shapes within the distance from 6 inches above the top of the joint to 6 inches below the bottom of the joint shall be checked by ultrasonic testing for laminations in base metal which may interfere with the inspection of the completed joint. Should these defects occur, members will be reviewed by the Architect and DSA. Welding procedure specifications in sub-section 1.5G specify welding practices to minimize lamellar tearing.
- I. Prior Testing of Base Material: Test material before fabrication.
- J. Lines and levels of erected steel shall be certified by a State of California licensed surveyor as set forth in related Division 01 section.
- K. Record Drawings: After steel has been erected, correct or revise Shop Drawings and erection diagrams to correspond with reviewed changes performed in the field.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify governing dimensions and conditions of the Work before commencing erection Work.
 - 1. Report discrepancies between drawings and field dimensions to Architect before commencing work.
 - 2. Beginning of installation means erector accepts existing conditions and surfaces underlying or adjacent to work of this section.
- B. Provide temporary shoring and bracing, and other support during performance of the Work. Remove after steel is in place and connected, and after cast-in-place concrete has reached its design strength.

3.02 ERECTION

- A. Install structural steel accurately in locations, to elevations indicated, and according to AISC specifications and CBC requirements.
- B. Clean surfaces of base plates and bearing plates.
 - 1. Install base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims; cut off flush with edge of base or bearing plate before packing with grout.
- C. Maintain erection tolerances of structural steel within AISC Code of Standard Practice for Steel Buildings and Bridges.
 - 1. Architecturally Exposed Structural Steel members and components, plumbed, leveled and aligned to a tolerance not to exceed one-half the amount permitted for structural steel. Contractor to provide adjustable connections between Architecturally Exposed Structural Steel and the structural steel frame or the masonry or concrete supports, in order to provide the erector with means for adjustment.
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact after assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
- E. Do not permit thermal cutting during erection of structural steel.
- F. Where indicated for field connections, provide standard bolts complying with ASTM A325.
- G. Install steel bolts at locations indicated. Assembly and installation shall be in accordance with CBC requirements.
 - 1. Allowable hole sizes: 1/16 inch larger than bolt size except as noted.
 - 2. Use friction type connection with standard hardened steel circular, square or rectangular washer under bolt nut.
 - 3. Thoroughly clean area under bolt head, nut and washer. Remove all paint, lacquer, oil or other coatings except organic zinc-rich paints in accordance with SSPC, SP-2.
 - 4. Tighten bolts by wrench until snug.

- H. Contractor shall be responsible for correcting detailing and fabrication errors and for correct fitting of all members and components.
- I. Erect structural steel plumb and level and to proper tolerances as set forth in the AISC Manual. Provide temporary bracing, supports or connections required for complete safety of structure until final permanent connections are installed.
- J. Steel Columns: Set column bases in exact position for alignment, plumb and straight, supported on adjustable bolt supports or shims until grout has set. Set center of base true to column center within 1/16" and adjust column height exactly. Maintain bases at exact position and level during grouting. Fill grout space solid with non-shrink grout.
- K. Provide anchor bolts with templates and diagrams/setting drawings. Verify position of bolts prior to delivery of steel. Contractor shall be responsible for proper location and installation of bolts. Correct deficiencies and errors.
- L. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A780.
- M. Connections: Hold steel in correct position during welding and bolting, and provide for dead loads, wind, and all erection stresses. Do no welding or final bolting until members have been aligned and plumbed.
 - 1. Field Welding: Conform to requirements for shop fabrication.
 - 2. Common Bolts: Tighten and upset bolt threads to preclude loosening, or use approved self-locking nuts.
- N. Damaged Members: During erection, straighten or replace members which are bent, twisted, or damaged as directed. If heating is required, perform heating by methods that ensure a uniform temperature throughout the entire member. When directed, remove members damaged to an extent impairing appearance, strength, or serviceability and replace with new members at no extra cost to the Owner.
- O. Employ qualified riggers and plan erection to require minimum cutting. Erect members plumb, true to line and level, and in precise positions. Provide temporary bracing and guying to resist loads and stresses to which the structure may be subjected, including those due to erection equipment and its operation.

3.03 FITTING

- A. Closely fit members, finished true to line and in precise position required to allow accurate erection and proper joining in the field.
- B. Drilling to enlarge unfair holes will not be allowed. Allow only enough drifting during assembly to bring parts into position, but not enough to enlarge holes or distort the metal. Do not heat rolled sections, unless approved by Architect.

3.04 PUNCHING AND DRILLING

- A. Punch material 1/16 inch larger than nominal diameter of bolt, wherever thickness of metal is equal to or less than the diameter of the bolt plus 1/8 inch.
- B. Drill or sub-punch and ream where metal is equal to or more than the diameter of the bolt plus 1/8 inch. Make diameter for sub-punched and sub-drilled holes 1/16 inch larger than nominal diameter of bolt.

- C. Precisely locate holes to ensure passage of bolt through assembled materials without drifting. Enlarge holes when necessary to receive bolts by reaming; flame cutting to enlarge holes is not acceptable. Structural Steel members with poorly matched holes will be rejected.

3.05 FINISHING

- A. After erection, spots or surfaces where paint has been removed, damaged, or burned off and field rivets, bolts, and other field connections not concealed in the work, shall be cleaned of dirt, oil, grease, and burned paint and furnished with a spot coat of the same primer installed during shop priming.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Install paint to exposed areas with the same material installed during shop painting. Install by brush or spray to provide a minimum dry film thickness of 2.5 mils.

3.06 FIELD QUALITY CONTROL

- A. Owner will provide a special inspector and independent testing laboratory to perform field inspections and tests and to prepare test reports.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. All welders shall be qualified for each process and position per the latest edition of AWS D1.1, Chapter 4, Part C - Performance Qualifications. The welder's qualification shall be considered as remaining in effect indefinitely unless the welder is not engaged in a given process of welding for which the welder is qualified for a period exceeding six months or unless there is some specific reason to question a welder's ability.
- D. Inspection of Shop Fabrication: Required for structural steel according to CBC Section 1704A.2.5.
- E. Inspection of Shop and Field Welding: Required for all structural steel according to CBC Section 1705A.2.
- F. Erection Inspection: Inspector shall inspect all erection including the grouting under base plates.
- G. Non-Destructive Welding Inspection: The Special Inspector(s) shall continuously inspect and test all welds by ultrasonic or other non-destructive tests as approved. Test procedure for ultrasonic tests shall conform to AWS D1.1 and requirements herein.
 - 1. Required Testing: Test following welds by ultrasonic testing method:
 - a. Full Penetration Groove welded connections of column to column, column to girder, girder to girder, and like connections.
 - b. Other welded connections indicated to be ultrasonically tested on Structural Drawings.
 - c. Other welds directed to be ultrasonically tested by the Architect, Structural Engineer, or Inspector Of Record.

2. Ultrasonic Testing: An AWS Certified Welding Inspector, approved by DSA shall operate ultrasonic testing equipment, examine welds, and maintain a record of welds examined, defects found, and disposition of each defect. Defective welds shall be repaired in accordance with AWS D1.1, latest revision, and costs for retesting defective welds shall be responsibility of the Contractor. Tests shall be complete tests according to AWS D1.1, latest revision.
3. Rate of Testing: Test welds requiring ultrasonic testing at 100 percent. No reduction in testing rate will be permitted.
4. Backing Strips: Remove backing strips whenever ultrasonic indications arising from weld roots can be interpreted as either a weld defect or a backing strip, and retest weld if no root defect is visible. If no defect is disclosed by retest and no significant amount of the base and weld metal is removed, joint needs no further repair or welding. Repair all defects disclosed. Contractor shall bear the cost of removals and repairs.
5. Ultrasonic Instrumentation: Calibrated by technician to evaluate the quality of welds in accordance with AWS D1.1-06, Sections 5 and 6.
6. Acceptance Criteria: In accordance with larger reflector criteria of AWS D1.1, latest revision.

3.07 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project Site.

3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.09 HANDLING

- A. Both in shop and in the field, transport, handle and erect to prevent damage or overstressing of any component.

END OF SECTION

SECTION 05 12 13

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Architecturally exposed structural steel (AESS).
2. Section 05 12 00 "Structural Steel Framing" requirements that also apply to AESS.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for [steel lintels and shelf angles not attached to structural-steel frame] [miscellaneous steel fabrications] [and] [other metal items] not defined as structural steel.
2. Section 09 96 00 "High-Performance Coatings for surface preparation and priming requirements.

1.02 DEFINITIONS

- A. AESS: Architecturally exposed structural steel.
- B. Category AESS 1: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 1 and may be designated AESS 1 or Category AESS 1 in the Contract Documents.
- C. Category AESS 2: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 2 and is designated as AESS 2 or Category AESS 2 in the Contract Documents.
- D. Category AESS 3: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 3 and is designated as AESS 3 or Category AESS 3 in the Contract Documents.
- E. Category AESS 4: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 4 and is designated as AESS 4 or Category AESS 4 in the Contract Documents.
- F. Category AESS C: Structural steel with custom characteristics that is categorized by ANSI/AISC 303, Section 10, as AESS C and is designated as AESS C or Category AESS C in the Contract Documents.
- G. SEAC/RMSCA Guide Specification: SEAC/RMSCA's "Sample Specification, Section 05 02 13: Architecturally Exposed Structural Steel."

1.03 COORDINATION

- A. Coordinate surface preparation requirements for shop-primed items.
- B. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.05 ACTION SUBMITTALS

A. Product Data:

1. Tension-control, high-strength, bolt-nut-washer assemblies.
2. Corrosion-resisting (weathering steel), tension-control, high-strength, bolt-nut-washer assemblies.
3. Filler.
4. Primer.
5. Galvanized-steel primer.
6. Etching cleaner.
7. Galvanized repair paint.

B. Shop Drawings: Show fabrication of AESS components. [Shop Drawings for structural steel may be used for AESS.]

1. Identify AESS category for each steel member and connection, including transitions between AESS categories and between AESS and non-AESS.
2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
3. Include embedment Drawings.
4. Indicate orientation of mill marks and HSS seams.
5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. [Indicate grinding, finish, and profile of welds.]
6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation and location of bolt heads.
7. Indicate exposed surfaces and edges and surface preparation being used.
8. Indicate special tolerances and erection requirements.
9. Indicate weep holes for HSS [and vent holes for galvanized HSS].
10. Indicate surface preparation, primer, and coating requirements, including systems specified in other Sections.

C. Samples: Submit Samples to set quality standards for AESS.

1. Two steel plates, 3/8 by 8 by 4 inches, with long edges joined by a groove weld [and with weld ground smooth].
2. Steel plate, 3/8 by 8 by 8 inches, with one end of a short length of rectangular steel tube, 4 by 6 by 3/8 inches, welded to plate with a continuous fillet weld [and with weld ground smooth and blended].
3. Round steel tube or pipe, minimum 8 inches in diameter, with end of another round steel tube or pipe, approximately 4 inches in diameter, welded to its side at a 45-degree angle with a continuous fillet weld [and with weld ground smooth and blended].

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [fabricator] [shop-painting applicator].
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172) and is experienced in fabricating AESS similar to that indicated on this Project.
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program, is designated an AISC-Certified Erector, [Category ACSE] [Category CSE], and is experienced in erecting AESS similar to that indicated on this Project.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint [Endorsement P1] [Endorsement P2] [Endorsement P3] or SSPC-QP 3.
- D. Mockups: Build mockups of AESS to set quality standards for fabrication and installation.
 - 1. Build mockup of typical portion of AESS as shown on Drawings.
 - 2. Coordinate painting requirements with [Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."]
 - 3. Coordinate high-performance coatings requirements with Section 09 96 00 "High-Performance Coatings."
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling AESS to prevent twisting, warping, nicking, and other damage during fabrication, delivery, and erection. Store materials to permit easy access for inspection and identification. Keep AESS members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect AESS members and packaged materials from corrosion and deterioration.
 - 1. Do not store AESS materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.09 FIELD CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of ANSI/AISC 303, Sections 1 through 9 and as modified in Section 10, "Architecturally Exposed Structural Steel."

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. Tension-Control, High-Strength, Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round-head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: [Plain] [Mechanically deposited zinc coating].
- B. Corrosion-Resisting (Weathering) Steel, Tension-Control, High-Strength, Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 3, round-head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 3, hardened carbon-steel washers.

2.03 FILLER

- A. Polyester filler intended for use in repairing dents in automobile bodies.

2.04 PRIMER

- A. Steel Primer:
 - 1. Comply with [Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings."] [Section 09 91 13 "Exterior Painting," Section 09 91 23 "Interior Painting," and Section 09 96 00 "High-Performance Coatings."]
 - 2. SSPC-Paint 23, latex primer.
 - 3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: .
 - 1. Etching Cleaner: MPI#25, for galvanized steel.
 - 2. Galvanizing Repair Paint: ASTM A780/A780M.

2.05 FABRICATION

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
 - 1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.
- B. Category AESS 1:
 - 1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.

3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
4. Make intermittent welds appear continuous, using filler or additional welding.
5. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
6. Limit butt and plug weld projections to 1/16 inch.
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.

C. Category AESS 2:

1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
4. Make intermittent welds appear continuous, using filler or additional welding.
5. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
6. Limit butt and plug weld projections to 1/16 inch.
7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
8. Remove weld spatter, slivers, and similar surface discontinuities.
9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
10. Grind tack welds smooth unless incorporated into final welds.
11. Remove backing and runoff tabs, and grind welds smooth.
12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.

D. Category AESS 3:

1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
 3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 4. Make intermittent welds appear continuous, using filler or additional welding.
 5. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
 6. Limit butt and plug weld projections to 1/16 inch.
 7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 8. Remove weld spatter, slivers, and similar surface discontinuities.
 9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 10. Grind tack welds smooth unless incorporated into final welds.
 11. Remove backing and runoff tabs, and grind welds smooth.
 12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
 13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
 14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
 15. Conceal fabrication and erection markings from view in the completed structure.
 16. Make welds uniform and smooth.
 17. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
 18. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
 19. Orient HSS seams as indicated or away from view.
 20. Align and match abutting member cross sections.
 21. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch. At closed joints, maintain uniform contact within 1/16 inch.
 22. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.
- E. Category AESS 4:
1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.

3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 4. Make intermittent welds appear continuous, using filler or additional welding.
 5. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
 6. Limit butt and plug weld projections to 1/16 inch.
 7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 8. Remove weld spatter, slivers, and similar surface discontinuities.
 9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 10. Grind tack welds smooth unless incorporated into final welds.
 11. Remove backing and runoff tabs, and grind welds smooth.
 12. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
 13. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
 14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
 15. Conceal fabrication and erection markings from view in the completed structure.
 16. Make welds uniform and smooth.
 17. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
 18. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
 19. Orient HSS seams as indicated or away from view.
 20. Align and match abutting member cross sections.
 21. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch. At closed joints, maintain uniform contact within 1/16 inch.
 22. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.
 23. Treat HSS seams to appear seamless.
 24. Contour and blend welds and weld transitions between members, removing splatter exposed to view.
 25. Fill surface imperfections with filler and sand smooth to achieve surface quality approved by Architect.
 26. Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.
- F. Erection marks, painted marks, and other marks are permitted on **[galvanized-] [corrosion-resisting (weathering)] steel** surfaces of completed structure.
- G. Cleaning Corrosion-Resisting (Weathering) AESS: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6 (WAB)/NACE WAB-3.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].
- B. Weld Connections: Comply with AWS D1.1/D1.1M[**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.07 GALVANIZING

- 1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
- 2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
- 3. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- 4. Galvanize AESS [**lintels**] <Insert description> attached to structural-steel frame and located in exterior walls.

2.08 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Corrosion-resisting (weathering) steel surfaces.
 - 5. Galvanized surfaces unless indicated to be painted.
- B. Surface Preparation: Clean nongalvanized surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
 - 3. SSPC-SP 7 (WAB)/NACE WAB-4.
 - 4. SSPC-SP 14 (WAB)/NACE WAB-8.
 - 5. SSPC-SP 11.
 - 6. SSPC-SP 6 (WAB)/NACE WAB-3.
 - 7. SSPC-SP 10 (WAB)/NACE WAB-2.
 - 8. SSPC-SP 5 (WAB)/NACE WAB-1.
 - 9. SSPC-SP 8.
- C. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner [**or according to SSPC-SP 16**].

- D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and eased edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments, showing dimensions, locations, angles, and elevations.
- B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION

- A. Take special care during erection to avoid marking or distorting the AESS and to minimize damage to shop painting. Set AESS accurately in locations and to elevations indicated and according to ANSI/AISC 303 and ANSI/AISC 360.
1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of temporary elements.
 2. Grind tack welds smooth.
 3. Remove backing and runoff tabs, and grind welds smooth.
 4. Orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 5. Remove erection bolts in **[Category AESS 4]** <Insert category> AESS, fill holes with weld metal or filler, and grind or sand smooth to achieve surface quality approved by Architect.
 6. Fill weld access holes in **[Category AESS 4]** <Insert category> AESS with weld metal or filler and grind, or sand smooth to achieve surface quality as approved by Architect.
 7. Conceal fabrication and erection markings from view in the completed structure.
- B. In addition to ANSI/AISC 303, Section 10 requirements, comply with the following.

1. Erection of [Category AESS 1] [and Category AESS 2]:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than 1/16 inch.
 - e. Continuous welds are to be of uniform size and profile.
 - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
 - g. Splice members only where indicated on Drawings.
 - h. No torch cutting or field fabrication is permitted.
2. Erection of Category AESS 3:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than 1/16 inch.
 - e. Continuous welds are to be of uniform size and profile.
 - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
 - g. Splice members only where indicated on Drawings.
 - h. No torch cutting or field fabrication is permitted.
 - i. Weld profiles, quality, and finish are to be as approved by Architect.
 - j. Make joint welds, including tack welds, appear continuous by filling intermittent welds.
3. Erection of Category AESS 4:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than 1/16 inch.
 - e. Continuous welds are to be of uniform size and profile.
 - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
 - g. Splice members only where indicated on Drawings.

- h. No torch cutting or field fabrication is permitted.
 - i. Weld profiles, quality, and finish are to be as approved by Architect.
 - j. Make joint welds, including tack welds, appear continuous by filling intermittent welds.
 - k. Grind welds smooth.
 - l. Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.
 - m. Oversize welds where ground, contoured, or blended, and grind to provide a smooth transition, matching profile approved by Architect.
4. Erection of Category AESS C:
- a. <Insert requirements>.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].
- B. Weld Connections: Comply with AWS D1.1/D1.1M[**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

3.05 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and touchup galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting, to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Cleaning and touchup painting are specified in Section 09 96 00 "High-Performance Coatings."
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 09 96 00 "High-Performance Coatings."

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect AESS as specified in Section 05 12 00 "Structural Steel Framing." The testing agency is not responsible for enforcing requirements relating to aesthetic effect.
- B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

END OF SECTION

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SECTION 05 12 19

BUCKLING RESTRAINED BRACES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes:
 - 1. Engineering, Fabrication, and Erection of Buckling Restrained Braces (BRB's).
- B. Provide all parts, materials, and labor required for the design, delivery, testing and erection of buckling-restrained braces, which are designed by the manufacturer to meet stiffness, yield strength, and elongation requirements as indicated on the Drawings and other requirements specified Herein.
- C. Related Sections:
 - 1. Division 01 – General Requirements.
 - 2. Section 05 1200: Structural Steel Framing.

1.03 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
 - 1. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section and as listed below. Refer to Section 05 1200.
 - a. A6 – Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling, latest edition.
 - b. A36 – Specification for Carbon Structural Steel, latest edition.
 - c. A325– Specification for Structural Bolts, 120/105 ksi Minimum Tensile Strength, latest edition.
 - d. A490 – Specification for Structural Bolts, 150 ksi Minimum Tensile Strength, latest edition.
 - e. A500 – Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes, latest edition.
 - f. A572 – Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel, latest edition.
 - g. F959 – Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, latest edition.
 - h. F1852 – Specification for “Twist-off” Type Tension Control Structural Bolts, 120/105 ksi Minimum Tensile Strength, latest edition

- i. F2280 – Specification for “Twist-off” Type Tension Control Structural Bolts, 150 ksi Minimum Tensile Strength, latest edition
 - B. American Institute of Steel Construction
 - 1. AISC 341 - Seismic Provisions for Structural Steel Buildings, including Supplements.
 - 2. AISC 360 Specifications for Structural Steel Buildings.
 - C. American Welding Society
 - 1. AWS D1.1 – Structural Welding Code - Steel.
 - 2. AWS D1.8 – Structural Welding Code – Seismic Supplement.
 - 3. 2.4 – Standard Symbols for Welding, Brazing and Nondestructive Examination.
 - 4. A5.1 –Specification for Carbon Steel Electrodes
 - 5. A5.18 –Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
 - 6. A5.20 – Carbon Steel Electrodes for Flux Cored Arc Welding
 - D. SSPC: Latest edition of Society for Protective Coatings surface preparation and painting specifications apply where cited in this Section.
- 1.04 DEFINITIONS
 - A. Buckling Restrained Brace (BRB): A steel brace consisting of an outer steel casing, an inner steel core, and a concrete matrix between the core and the outer steel casing. The inner steel core resists against tensile and compressive axial loads and is restrained from buckling by the concrete contained in the outer steel casing.
- 1.05 DESIGN AND PERFORMANCE REQUIREMENTS
 - A. Physical Requirements:
 - 1. The net area of the steel core shall be as designated on the Drawings.
 - 2. The casting shall not exceed the maximum dimensions designated on the Drawings, without written approval of Owner’s Representative.
 - B. Performance Criteria:
 - 1. Braces shall provide for stable cyclic displacement (lengthening and shortening), corresponding to the acceptance criteria of ANSI/AISC 341, Section K3.8.
 - C. Design Requirements:
 - 1. Manufacturer’s Engineer shall design the following components to achieve the Performance Criteria:
 - a. Braces
 - b. Connection of Brace to Gusset Plate
 - c. Gusset Plate
 - d. Connection of Gusset Plate to primary structural columns and beams.

Design shall be based on detailed examination and understanding of the results of qualifying cyclic tests and interpolation of results to project conditions.

Where bracing connections are designed by manufacturer, they shall be designed to a minimum of 1.1 times the adjusted brace strength as defined in Article 2.4.F. Connection design shall include length effects for long BRBs as described in Article 2.3.F.

2. Interpolation of test results for different member sizes shall be justified by rational analysis that demonstrates stress distributions and magnitudes of internal strains that are consistent with or less severe than the tested assemblies and that considers the adverse effects of larger material properties and variations in material properties. Consider the effect of imposed end rotations.
 3. Buckling-restrained braces longer than 35 feet (or greater than 200% of the qualifying test specimen) shall account for length effects in the determination of the compression overstrength factor (ϕ). BRB manufacturer shall submit design methodology to justify values used to determine length effects. This methodology must include the comparison of test results of at least (2) long BRBs (minimum of 40 feet long) to a control sample of one-half the length of the long specimen. Both the control sample and the long specimen shall be of similar capacity ($\pm 5\%$) for comparison.
 4. End rotation effects corresponding to the larger of 2.0 times Design Story Drift or .025 radians minimum shall be considered.
- D. Qualification Tests: The design of braces shall be based on results from qualifying cyclic tests. Test shall consist of at least two successful cyclic tests: one is required to be a test of a brace sub-assembly that includes brace connection imposed rotations and the other may be either a uniaxial or sub-assembly test.
1. Qualification tests shall conform to requirements of ANSI/AISC 341, Section K3.
 2. Qualification tests are permitted to be based on documented full-scale cyclic tests performed for other projects or tests reported in research, provided that there is sufficient basis for extrapolation to project conditions.
- 1.06 SUBMITTALS
- A. Qualification Testing Report: Conform to requirements of ANSI/AISC 341, Section K3.7.
 - B. Certified Manufacturer's Quality Assurance Plan: Conform to requirements of "Quality Assurance".
 - C. Manufacturer's in-house Quality Assurance Inspection Report for each brace upon completion of fabrication.
 - D. Brace Design: Submit drawings and calculations signed by the Manufacturer's Engineer.
 1. Design Drawings: Provide drawings, calculations and certifications that include the size and configuration of steel core for full length of BRB. Indicate casing size and length. Provide details of welding. The Brace manufacturer's engineer shall seal and sign final calculations, drawings and required certification.
 - E. Certified material test reports: Submit to Owner's Testing Laboratory for record purposes.
 1. Tensile tests and chemical analysis for all steel.
 2. Independent coupon tests used to verify core plate initial yield stress, tensile stress, and ultimate elongation.

- a. Where core plates are fabricated from plate material, coupon tests shall be performed on each plate.
 - b. Where core plates are fabricated from bar stock, coupons shall be made at intervals of each 5 tons of material of same heat and thickness.
 - c. Coupon tests to be taken at point of manufacture. Mill test reports (MTR) may not be used.
3. Plates 2 inches (50mm) and thicker shall be supplied with Charpy V-Notch testing in accordance with ASTM A673, Frequency P, or approved equal. The impact test shall meet a minimum average value of 20 ft-lbs absorbed energy at +70 degrees Fahrenheit and shall be conducted in accordance with AISC Specification, or approved equal.
- F. Erection Drawings: Show location and size of BRB's, including size, thickness, and length of exterior brace casing as well as configuration and size of the full length of the core plates. Provide complete information necessary for fabrication of elements of structural steel frame to receive braces and fabrication of connection plates. Show methods of assembly, including type and size of bolts, hole diameter, and preparation and finish of faying surfaces. Identify tolerances for fabrication and erection.
- G. Testing and Inspection Records: Submit Quality Assurance test and inspection reports to Testing Laboratory for record purposes prior to shipping of braces.
- H. Welding Certificates
1. Welder Performance Qualification Records (WPQR's)
 2. Welding Procedure Specification (WPS) written in conformance with AWS D1.1 for each proposed type of welded joint, whether pre-qualified or qualified by testing.
- I. Outside Testing Agency Quality Control Report where applicable.
- 1.07 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Shall have manufactured and successfully tested braces of sizes required for this project.
- B. Design Engineer Qualifications: Civil Engineer, registered in the State of California that is knowledgeable with the results of cyclic testing BRB's and experienced in the design of BRB's based on engineering analysis.
1. Engineer may be an employee of brace manufacturer.
- C. Quality Assurance Plan: Manufacturer shall have a detailed Quality Assurance Plan to evidence that the BRB's being manufactured are of the same quality as those tested, including:
1. Welding procedures.
 2. Methodology for verifying and documenting material properties.
 3. Indication of how the product is to be identified, such that it can be traced back to production quality assurance records.
 4. A flow chart of the process by which the product is manufactured, including description of production methods.
 5. Identified manufacturing tolerances for each production process.
 6. In-process quality control including all points of internal inspection for control and monitoring of the fabrication and assembly process.

- D. Qualification Testing: Refer to Section 1.05D, "Qualification Tests" for requirements.
1. Extrapolation of Qualification Testing: All deviations from materials, details of fabrication, and quality assurance controls used for the fabrication of tested prototype braces shall be identified by manufacturer and reviewed by Design Engineer to ensure that production braces met or exceed the level of quality used in fabrication of prototype braces.
- E. Coupon Testing:
1. Sample and tension test each steel plate for brace core in accordance with ASTM E8, plate-type tests.
 2. Take samples from plates at point of brace manufacture.
 - a. The axis of the test specimens shall be parallel to the axis of the brace core; no testing transverse to axis of brace core in required.
 - b. The end of the test specimen shall be located 6 inches minimum from the end of plate.
 - c. The centerline of the test specimen shall be located at the center of steel bars and not closer than 8 inches to a rolled edge of plate.
 3. Report initial yield, yield at 0.2% offset, tensile strength, and elongation for each specimen. Report average yield at two percent offset for each sample (of 3, or more, specimen tests).
 4. When the average yield (at 0.2% offset) for a sample falls outside of the specified tolerances, the steel shall be rejected for use on the project.
- F. Erect mock-up of brace end and connection per Section 05 1200: Structural Steel.
- G. The Manufacturer shall notify Owner of fabrication schedule at least 30 days prior to fabrication in order to allow Owner or Owner's Representative to observe fabrication process.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Store braces above grade on platforms, skids or other supports.
- B. Protect steel from corrosion.
- C. Store other materials in a weather-tight and dry place until installed into the Work.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. An acceptable manufacturer will have successfully completed qualification testing of braces similar to those required for the project and will be subject to compliance with other requirements of the Contract Documents, including limitations on maximum brace dimensions. Also, an acceptable manufacturer is one that has completed DSA projects (of similar size) in the past ten (10) years.
- B. Plants fabricating buckling-restrained braces shall comply with the following:
 1. Obtain and maintain accreditation from The American Institute of Steel Construction (AISC Certified Fabricator) in conjunction with any additional certifications required by the local jurisdiction.

2. Have a minimum of 5 years of documented continuous experience in the fabrication of buckling-restrained braces with a minimum of 30 completed projects over this same period.
 3. Buckling-restrained braces for this project shall be manufactured in the same facility (following the same quality assurance procedures) as the braces manufactured and tested to fulfill the AISC 341 testing requirements.
- C. Buckling-Restrained Braces shall be manufactured and supplied by the following vendor or equal.
1. CoreBrace, LLC
5789 West Wells Park Road
West Jordan, UT 84081
801.280.0701

Documentation showing evidence of valid accreditation and experience shall be submitted to the Engineer of Record during the bidding phase for any proposed manufacturer not listed above.

2.02 MATERIALS

- A. Core Plate
1. ASTM A36 with F_y as noted on the drawings.
 - a. F_y of all core plate material shall be verified via coupon test per Article 1.4.D.2.
 - b. Core plates 2 inches (50mm) and thicker shall be supplied with Charpy V-Notch testing per Article 1.4.D.3.
 - c. If not noted on the drawings, use $38\text{ksi} \leq F_y \leq 46\text{ksi}$
- B. Casing
1. ASTM A500, Gr. B or similar for square or rectangular sections.
 2. ASTM A500, Gr. B or A53, Gr. B or similar for round sections.
- C. Welding Materials
1. Shielded metal arc welding electrodes conform to AWS A5.1, flux-cored arc welding electrodes conform to AWS A5.20, and electrodes used for gas metal arc or submerged arc conform to the requirements of AWS A5.18.
 2. The minimum tensile strength of the E70 class electrodes used in production is 70,000 psi (470 MPa).
 3. Materials shall provide production welds with minimum Charpy V Notch properties of 20 ft-lbs (27 J) at -20°F (-30°C).
- D. Shop Primer: In accordance with Section 05 2100.
- E. Debonding Agent: Manufacturer's standard; demonstrated suitable to maintain separation of steel core and grout encasement when subjected to a minimum of 30 cycles of inelastic yielding at 2.0 percent strain; resistant to aging effects for a life cycle of 50 years.
- F. Fill Material: Manufacturer's standard cementitious grout; demonstrated suitable for function as a confining in-fill material by subassembly qualification testing.
1. Grout shall have a minimum compressive strength of 3500 psi at 28 days (ASTM C109).

G. Bolts, Nuts, and Washers:

1. ASTM A325 or A490 for conventional high-strength bolts (F3125),, ASTM A563 nuts.
2. ASTM 1852 or F2280 for twist-off type Tension Control Bolt/Nut/Washer Assemblies.

2.03 FABRICATION

A. Fabricate steel in accordance with Section 05 1200: Structural Steel for members part of the Seismic Force Resisting System. Braces shall be fabricated in accordance with AISC Code of Standard Practice and in an AISC Certified Shop that participates in the AISC Quality Certification Program.

B. Core Plates

1. The general roughness cannot exceed 1000 micro-inches in the yielding length.
2. Cut core plates to profile shown on manufacturer's design drawings. Conform to tolerances of manufacturer's Quality Assurance Manual, except tolerance on plate width shall not exceed plus or minus 0.2 inches (5mm).
3. Axis of core plates shall be parallel to rolling direction of steel plate.
4. Splices in the steel core shall not be permitted.
5. Roughness: After cutting, edges of core plates shall have surface finish better than Sample 3, AWS C4.1.
6. Gouges and Notches: Occasional gouges and notched less than 0.2 inches (5 mm) deep in edges of core plates may be repaired by grinding to a smooth transition. The length of transition shall be a minimum of 10 times the depth of gouge. The area shall be inspected by MT after grinding to ensure the entire depth of gouge has been removed. Deeper gouges shall be cause for rejection of piece.
7. Welding: Continuously weld intersections of cruciform plates. The detailing and finishing of weld terminations shall meet or exceed quality of tested assembly.

C. Holes: Bolted and pin connections shall conform with the requirements of ANSI/AISC 360.

1. Standard holes for bolted connections, except that single ply plated connections may use oversized holes
2. Holes for pins shall be a maximum of 1/32-inch larger than the diameter of the pin.

D. Assembly: Assemble components of the Buckling Restrained Brace in a manner to ensure proper performance of the brace.

1. Examine steel core areas for straightness prior to coating with debonding agent.
2. Provide end-conforming plates to ensure confinement of the fill material while allowing for non-restricting movement of the steel core.

E. Finishes: Except as otherwise designated on Drawings, conform to the following finish and painting schedule, in accordance with requirements of Division 05 Section, Structural Steel Framing:

1. Interior, concealed by finishes or spray fireproofed: SSPC-2 surface preparation; shop primed with manufacturer's standard shop primer, except faying surfaces of bolted connections, surfaces that will be field welded, exposed surfaces that shall be galvanized and surfaces to receive spray fireproofing.

2. Interior, exposed and finish painted: SSPC-6 surface preparation; shop paint with Type A primer, except at faying surfaces of bolted connections, surfaces that shall be galvanized and surfaces to receive spray fireproofing.
3. Do not paint connection faying surfaces if connection are designated slip critical unless paint used provides same slip resistance

2.04 SOURCE QUALITY CONTROL

- A. Inspection and testing will be performed under in accordance with procedures and administrative requirements of Division 01 Section.
- B. Owners Testing Agency will:
 1. Review Manufacturer's Quality Assurance Plan, mill certificates and coupon test report.
 2. Review Manufacturer's quality assurance test and inspection reports.
- C. Contractor shall:
 1. Notify Owner's Representative no less than 30 days before the start of fabrication of the buckling restrained braces, to allow Owner's Representative to observe fabrication and assembly process.
 2. Perform testing and inspection in accordance with approved Quality Assurance Plan and requirements of Contract Documents.

2.05 PERFORMANCE REQUIREMENTS

- A. Core plate material shall have a yield range of 42 ksi within ± 4 ksi unless indicated otherwise in the structural BRB drawings. Coupon tests taken from plates at point of manufacture of BRBs shall be used to verify conformance. Additional coupon tests may be performed to replace coupon tests that fall out of acceptable range.
- B. Increasing amplitude cyclic displacement tests per the AISC Seismic Provisions shall provide stable performance up to a displacement corresponding to 2.0 x Design Story Drift.
 1. Hysteretic behavior shall display no post-yield loss of strength, degradation, or pinching.
 2. Fracture of any portion of the BRB shall not occur during the qualifying tests.
 3. The cumulative ductility factor requirement specified in AISC 341 shall be increased from 200 to 300.
- C. The steel core shall resist compression and tension forces. The steel core area shall be as per the project drawings and based on the yield stress range specified.
- D. The steel and concrete casing shall prevent the steel core from buckling globally and locally during compressive loading without binding due to longitudinal shortening and transverse expansion. Demand for local and global stability of casing checks shall be based on the adjusted brace strength at the maximum yield stress ($F_{y,sc,max}$) of the specified yield stress range of the core plate material. Casing design shall include length effects for long BRBs as described in Article 2.3.F.
- E. Steel core projections beyond the steel casing and brace connections shall develop the adjusted brace strength without instigation of fracture or instability. For core plate checks use the minimum ($F_{y,sc,min}$) of the specified yield stress range for determining demand. For all other materials use $F_{y,sc,max}$ to determine demand.

- F. The overstrength factors (Ω) shall be determined at a brace strain level associated with the greater of a 2% interstory drift or twice the design story drift, the latter of which is taken as $(2\Omega C_d F_{y,sc,min})/(\rho I_e E)$. Where P_d is provided, twice the design story drift is taken as $(2C_d P_d)/(A_{sc} \rho I_e E)$. C_d is the design drift deflection amplification factor, E is the nominal modulus of elasticity of the core plate material, I_e is the Importance Factor, Ω is the Redundancy Factor, and P_d is the demand in the BRBs at the controlling drift design load case with gravity loads excluded. Compression overstrength determination shall include the effects of brace length as described in Article 2.3.F.

2.06 QUALIFICATION TESTS

- A. Buckling-restrained brace design shall be based on two qualifying cyclic tests conforming to the AISC Seismic Provisions for Buckling Restrained Braced Frames. As stated in the Provisions, at least one of the two qualifying tests needs to be a subassembly test to demonstrate the ability of the BRB to withstand rotational demands. The other test may be performed uniaxially or may also be a subassembly test.
- B. The requirements of the AISC 341 Seismic Provisions shall be met along with the modification in Article 2.4.B.3.
- C. The strain level during testing shall be equivalent to, or greater than, the strains that the project braces will be expected to withstand.
- D. Qualifying cyclical tests can be based on full-scale cyclical tests previously reported for projects, or research that are deemed similar to project conditions by the Manufacturer and Project Engineer.
- E. Qualification testing of long braces, if BRBs on this project are of sufficient length, as required in Article 2.3.F.

PART 3 – EXECUTION

3.01 ERECTION

- A. Braces are erected under Section 05 1200: Structural Steel for members part of the Seismic Force Resisting System.
- B. Prior to erection, clean faying surfaces of brace to be in contact with bolted connections to remove temporary coatings applied for transport and surface containments.
- C. Buckling restrained braces shall not be field cut or altered. Alterations to structural steel components to receive Buckling Restrained Braces shall be as permitted by Section 05 1200: Structural Steel.
- D. No field welding to buckling restrained brace members will be permitted, including attachment of nonstructural components.
- E. Prior to erection, clean faying surfaces of BRB to be in contact with bolted connections to remove temporary coatings applied for transport and surface contaminants.
- F. No field cutting or altering is permitted without the approval of the manufacturer and EOR.

3.02 FITTING

- A. Closely fit members, finished true to line and in precise position required to allow accurate erection and proper joining in the field.
- B. Drilling to enlarge unfair holes will not be allowed. Allow only enough drifting during assembly to bring parts into position, but not enough to enlarge holes or distort the metal. Do not heat rolled sections, unless approved by Architect.

3.03 PUNCHING AND DRILLING

- A. Punch material 1/16 inch larger than nominal diameter of bolt, wherever thickness of metal is equal to or less than the diameter of the bolt plus 1/8 inch.
- B. Drill or sub-punch and ream where metal is equal to or more than the diameter of the bolt plus 1/8 inch. Make diameter for sub-punched and sub-drilled holes 1/16 inch larger than nominal diameter of bolt.
- C. Precisely locate holes to ensure passage of bolt through assembled materials without drifting. Enlarge holes when necessary to receive bolts by reaming; flame cutting to enlarge holes is not acceptable. Structural Steel members with poorly matched holes will be rejected.

3.04 FINISHING

- A. After erection, spots or surfaces where paint has been removed, damaged, or burned off and field rivets, bolts, and other field connections not concealed in the work, shall be cleaned of dirt, oil, grease, and burned paint and furnished with a spot coat of the same primer installed during shop priming.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Install paint to exposed areas with the same material installed during shop painting. Install by brush or spray to provide a minimum dry film thickness of 1.5 mils.

3.05 FIELD QUALITY CONTROL

- A. Owner will provide a special inspector and independent testing laboratory to perform field inspections and tests and to prepare test reports.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Manufacturer to package BRB's for protection against shipping damage.
- D. Manufacturer shall coordinate delivery dates and quantities with Contractor/Owner. Contractor/Owner shall provide adequate storage space and proper lay-down areas.

3.06 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project Site.

3.07 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.08 HANDLING

- A. Both in shop and in the field, transport, handle and erect to prevent damage or overstressing of any component.

END OF SECTION

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SECTION 05 31 00

STEEL DECKING

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section.
- B. Section Includes:
 - 1. Metal decking as indicated.
 - 2. Shear connectors.
 - 3. Bent plate and sheet metal closures at decking edges and openings.
 - 4. Holes through decking, with reinforcing.
- C. Related Sections:
 - 1. Section 01 41 00: Testing and Inspection.
 - 2. Section 05 12 00: Structural Steel
 - 3. Section 07 60 00: Flashing and Sheet Metal.

1.02 REFERENCES

- A. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
- B. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- D. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- E. AWS D 1.3 – Structural Welding Code Sheet – Steel.
- F. AISI – Specifications for the Design of Cold-Formed Steel Structural Members.

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Compute properties of deck sections on basis of effective design width as limited by provisions of the AISI specifications. Provide no less than deck section properties specified, including section modulus and moment of inertia per foot of width.
- B. Regulatory Requirements:

1. Requirements of Regulatory Agencies: DSA and Underwriters Laboratories Inc. (UL) approval for the decking when installed as a part of an assembly indicated on Drawings in which fire resistive construction ratings are required.
2. Work of this section shall be in accordance with CBC.

1.04 SUBMITTALS

- A. Shop Drawings: Submit drawings fully detailing and dimensioning all steel decking including accessories, fastenings, welding, holes with reinforcing, flashings, and closures. Indicate welding according to AWS Standard Welding Symbols. Show dimensioned layouts for openings and reinforcing details.
- B. Calculations and Data: If steel decking of type differing from that indicated or specified is proposed, submit the manufacturer's calculations and supporting data showing that proposed decking conforms to requirements indicated and specified. Include the decking manufacturer's technical product data and copies of code approvals (including ICC report) for proposed decking. Submit with shop drawings and obtain approval prior to fabrication and delivery of decking.
- C. LEED Documentation: Submit the following documentation
 1. Specific product name, make, model, and manufacturer
 2. Material Cost
 3. Post-Consumer Recycled Content: Cutsheets, product literature or letter from the manufacturer indicating the percentage by weight of post-consumer (post-industrial) recycled content.
 4. Extracted, Manufactured, and Purchased locally. Provide cutsheets, product literature or letter from the manufacturer indicating the location of extraction, manufacturing, and purchasing and distance from the project site.

1.05 QUALITY ASSURANCE

- A. General: Metal decking steel shall conform to requirements of strengths and properties of standards specified.
- B. Qualifications of Welders: Properly certified for the type of Work involved in compliance with CBC requirements and AWS D1.3.
- C. Continuous inspection of welding will be performed by a special inspector, approved by DSA to inspect the Work of this section. Refer to Section 01 41 00: Testing and Inspection. The IOR shall be responsible for monitoring the work of the special inspector to ensure that the inspection program is satisfactorily completed.
- D. Identification of metal decking steel shall conform to the standards specified in Section 01420: Testing and Inspection.
 1. Fabricator shall furnish sufficient evidence to the Architect attesting compliance with specified requirements.
 2. Conform to CBC requirements. Unclassified or unidentified decking is not permitted. Furnish deck manufacturer's certified mill analyses and test reports for each heat covering decking having a minimum Fy of 33 Ksi. In addition, for decking having Fy greater than 33 Ksi, testing laboratory shall perform one tension and elongation test and one bend or flattening test for each gage.

- E. Unidentifiable Steel: Steel which is not readily identifiable as to grade from markings and test records is not permitted to be provided as part of the Work of this section.
- F. Metal Decking Shall be in conformance with the following:
 - 1. AISI "Specification for Design of Light Gauge Steel Members".
 - 2. AISI "Specification for Design of Cold Formed Steel Members".
 - 3. Steel Deck Institute Publication No. 29 "Design Manual for Composite Decking, Form Decks and Roof Decks.
- G. Payment For Tests and Inspections:
 - 1. Owner shall pay inspection and testing costs of identifiable steel.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Deck West
- B. Verco Manufacturing Inc.
- C. ASC Steel Deck
- D. Members of Steel Deck Institute (SDI)

2.02 MATERIALS

- A. Metal Decking: Roll-formed sheets conforming to ASTM A653, Grade 33, minimum yield strength of 38,000 psi, with G60 zinc coating, unless otherwise noted.
 - 1. Section properties shall conform to applicable provisions of latest edition of AISI - Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. Deck lengths to span over at least three spans unless otherwise indicated. Each panel shall be factory slotted or have rolled-in moisture venting provisions.
- B. Flexible Closure Strips for Deck: Vulcanized, closed-cell, expanded chloroprene elastomer, complying with ASTM D1056, Grade SCE #41.
 - 1. Brittleness Temperature: Minus 40 degrees F, ASTM D746.
 - 2. Flammability Resistance: Self-extinguishing,
- C. Metal Flashing and Closures: 22 gage minimum, with ASTM A653, G60 zinc coating.
- D. Shear Connectors: Headed stud type, ASTM A108 Grade 1015, cold-finished carbon steel complying with AISC specifications.

- E. Decking Accessories: Provide indicated and required decking accessories including, without limitation, welding washers and welding anchors, closures, transitions, and filler strips, as required for complete installations. Provide bent plate closures, angles, channels, and attachments as required for openings through decking for ducts, shafts, piping, and other penetrations; where decking changes direction; and at decking perimeter; fabricated of 16 gage galvanized steel unless otherwise shown on the Structural Drawings. Provide roof drain and overflow sumps of minimum 14 gage galvanized steel.
- F. Galvanizing Repair Paint: Zinc rich paint conforming to Mil Spec MIL-P-21035 (SHIPS)

2.03 FABRICATION

- A. Corrugated sheets or sections shall be designed to support required live load between supporting members.
- B. Wherever practical, provide decking in lengths to span over three or more supports.
- C. Except as detailed otherwise, provide decking with interlocking side laps, 2-1/2 inches minimum end bearing, and 1-1/2 inches minimum side bearing.
- D. Welding: Provide materials and methods in accordance with recommendations of steel decking manufacturer and reviewed submittals. Hold decking tight to the supporting elements with screws or other means for proper welding or crimping of the decking edges. Conform to AWS D1.3, CBC Standards, and to the patterns and weld types indicated, with welds free from sharp edges and protrusions. Field coat welds and abraded surfaces at completion with an anodic type galvanizing repair paint. Omit the field paint coating where welds or abrasions are covered by concrete fill or sprayed fireproofing.

PART 3 - EXECUTION

3.01 OPENINGS

- A. Cut and reinforce units to provide openings which are located and dimensioned on the structural and mechanical Drawings.
- B. Provide openings, as approved by the Architect and DSA, for other Work not indicated on the Drawings.

3.02 INSTALLATION

- A. Install metal decking in accordance with decking manufacturers' recommendations, requirements of Drawings, Shop Drawings, and Specifications.
- B. Install metal decking on supporting steel framework and adjust to final position before permanently fastening in place.
 - 1. Install each unit to proper bearing on supports.
 - 2. Install units in straight alignment for entire length of run of cells with close registration of cells of one unit with those of abutting unit.
 - 3. Do not splice units except at supports. Conform to code approvals and approved submittals.

- C. Fasten decking to steel framework at ends of units and at intermediate supports. Welding shall be as indicated on Drawings.
- D. Fasten side laps between supports as indicated on Drawings.
- E. Cutting and Fitting: Perform cutting and fitting at columns, perimeters, shafts, stairs, and other openings. Provide tight fitting closures at the open uncovered ends and edges of decking, and all miscellaneous supports required to carry the metal decking. Secure hole reinforcement to decking with fillet welds placed on both sides of reinforcing members. Place reinforcement channels and angles across flutes and to project a distance beyond sides of openings equal to the maximum size of the opening unless otherwise shown. Perform field cutting and trimming square and neat, equal to factory cutting.
- F. Welding: Use materials and methods in accordance with recommendations of steel decking manufacturer and approved submittals. Hold decking tight to the supporting elements with screws or other means as directed for proper welding or crimping of the decking edges. Conform to AWS D1.3 and to the patterns and weld types indicated, with all finished welds free of sharp points or edges. Field coat welds and abraded surfaces at completion with an approved anodic type galvanizing repair paint. Omit the field paint coating where welds or abrasions are covered by concrete fill or sprayed fireproofing.
- G. Weld shear connectors to supports thru decking units as required by Drawings. Weld only on clean, dry surfaces. Do not weld shear connectors thru two layers of decking units.
- H. Damaged Decking: Remove and replace all metal decking showing denting or other damage that adversely affects decking strength or subsequent materials, as directed.

3.03 METAL FLASHINGS AND CLOSURES

- A. Furnish, install, and weld in position, sheet metal closure flashing, closure angles, closure plates, profile plates, and shear plates.
- B. Close open ends of cell runs at columns, openings, walls, similar interruptions and termination.

3.04 FIELD QUALITY CONTROL

- A. Inspection: Install steel decking under continuous inspection according to CBC Chapter 17A, 1704A.3.1.1.
 - 1. Welding inspection for steel deck diaphragms shall conform to CBC Section 2204A.1.

3.05 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.06 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

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SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section.
- B. Section Includes:
 - 1. Load-bearing metal stud systems.
- C. Related Sections:
 - 1. Section 01 41 00: Testing and Inspection.
 - 2. Section 05 12 00: Structural Steel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings showing framing, connection details, accessories and anchorage. Indicate location of assemblies, size and spacing of framing components.
- B. Product Data: Submit manufacturer's catalog data for each item proposed for installation.
- C. Certificates: Furnish manufacturer's certification that materials meet or exceed Specification requirements.
- D. Weld Procedures: Submit weld procedures, procedure qualification records, and electrode product data for review and approval.

1.03 QUALITY ASSURANCE

- A. Comply with following as a minimum requirement:
 - 1. AISI - Specifications for Design of Cold Formed Steel Structural Members.
 - 2. Welds shall be performed by AWS certified welders. Welding shall be performed in accordance with requirements of American Welding Society (AWS) Structural Welding Code-Steel D1.1 and D1.3. Structural welding Code-Sheet Steel.
 - 3. Welding shall be inspected by a special inspector, approved by DSA to inspect Work of this section. The IOR shall be responsible for monitoring work of special inspector to ensure that inspection program is satisfactorily completed.
 - 4. ASTM A 924 – Standard Specification for General Requirements for Steel Sheet Metallic-Coated by Hot-Dip Process
 - 5. ASTM A 1003 – Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

6. ASTM A 1008 – Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.
 7. ASTM C 954 – Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks) and Bracing or Bridging for Screw Application of Gypsum Panel Products and Plaster Bases.
 8. ASTM C 955 – Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
 9. ASTM A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by Hot Dip Process.
 10. ASTM C 1007 – Standard Specification for Installation of Structural (Axial and Transverse) Steel Framing Members and Accessories.
 11. ASTM E 488 – Standard Test Methods of Strength Anchors in Concrete and Masonry.
 12. ASTM E 1190 – Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.
- B. Tolerances: Install walls and partitions on straight lines, plumb, free of twists or other defects, and contacting a 10 foot straightedge for its entire length at any location within a 1/8 inch tolerance. Install horizontal framing level within a tolerance of 1/8 inch in 12 feet in any direction.
- 1.04 DELIVERY, STORAGE AND HANDLING
- A. All materials shall be delivered in their original unopened packages and stored protected from damage. Do not store material directly on grade. Provide adequate support to prevent bowing of material prior to installation. If it is necessary to store materials outside, stack them off the ground on a platform and fully protected from the weather.
- B. Store welding electrodes in accordance with AWS D12.1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide studs, tracks, joists and accessories manufactured by one of following:
1. Steel Studs Manufacturer's Association; ICC-ES ER4943P
 2. California Expanded Metal Products Co.; ICC-ES ER3403-P
- B. Special Connection Accessories: Products manufactured by The Steel Network, Inc., or equal.

2.02 MATERIALS

- A. Light Gage Metal Framing:
1. Metal framing shall be formed from corrosion resistant-steel conforming to requirements of ASTM A 653, 50 ksi minimum. Galvanize per ASTM A924, Designation G60.
 2. Metal framing shall be manufactured in conformance to ASTM C 955.

3. Install metal framing per ASTM C 1007, Standard Specification for Installation of Load-Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- B. Gages and properties of studs shall be as indicated on Drawings.
 - C. Mechanical anchors to concrete and masonry shall be metal cinch at least 3/8 inch in diameter threaded bolt head type. Anchor bolts to be installed in concrete shall be hook type 1/2 inch diameter or more. Unless otherwise indicated.
 - D. Mechanical anchors to metal framing shall be No. 10 self-tapping and self-drilling wafer-head screws unless noted otherwise.
 - E. Accessories: Special top tracks, angles, fasteners, and strips of gypsum wallboard, as required for fire rating assembly required at each condition.
 - F. Mineral Wool: Thermafiber Safing Insulation or equal.
 - G. Galvanizing Repair Compound: High zinc dust content galvanizing repair paint meeting the requirements of ASTM A 780-00 or hot applied zinc rich material. Provide one of the following available products or another product complying with the referenced standard:
 1. American Solder & Flux; Drygalv
 2. Kenco Div.; Galvicon
 3. Metalloy Products, Co.; Galvalloy
 - H. Framing Accessories:
 1. Fabricate steel-framing accessories of the same material and finish used for framing members, with a minimum yield strength of 33,000 psi unless noted otherwise on contract documents.
 2. Provide accessories noted below, of thickness and configuration indicated on the Drawings. Where not indicated provide accessories manufacturer's standard of thickness and configuration.
 - a. Supplementary framing.
 - b. Bracing, bridging, and solid blocking.
 - c. Stud kickers, knee braces, and girts.
 - d. Hole reinforcing plates.
 - e. Backer plates.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.02 INSTALLATION

- A. Erect straight, plumb, square, true to lines, levels or elevations indicated, free from excessive twists and bends and braced against racking.
- B. Anchor top and bottom runner track to ceiling or roof structure overhead and to floor structure below.
- C. Install studs squarely in top and bottom runner track with firm abutment against track webs.
- D. Align and plumb studs, and fasten to flanges of both top and bottom runner tracks.
- E. Provide 3 studs minimum at corners of stud walls. Locate so as to provide surfaces for attachment of interior and exterior facing materials.
- F. Members not indicated to be welded together shall be attached with manufacturer recommended screws with minimum one screw at each flange of stud to top and bottom track. Wire tying of framing members is not permitted.
- G. Provide lateral bracing and bridging in accordance with manufacturer's written recommendations or as required by CBC.
- H. Intersecting walls and partitions, whether load-bearing or not, shall be connected.
- I. Splices in axially loaded studs are not permitted.
- J. Splice or butt weld butt joints in runner tracks. No splices are permitted in tracks over lintels, diaphragm sheathing, or diagonal bracing.
- K. Weld connections by fillet welds or plug welds in accordance with AWS recommended procedures and practices.
- L. Touch up abrasions, burns, and welding, including construction activities of other trades, with primers for primed steel or with galvanizing compound if galvanized. Remove oil, grease, rust, loose scale, loose coatings, weld slag and other deleterious material before touch-up.
- M. Studs that frame door openings shall be clipped to floor with 14 gage angle clips. Each clip to have two fasteners into studs and two fasteners into floor.
- N. Provide additional joists or blocking adjacent to exterior and interior walls, openings and elsewhere as required to provide support for indicated ceiling construction.
- O. Provide an additional joist under parallel partitions where partition length exceeds 1/2 joist span and around floor and roof openings which interrupt one or more spanning members.
- P. Conform to rules and practices set forth in ASTM C 1007-00, and with the manufacturer's printed instructions and recommendations, as applicable.
- Q. Cut stock neat and square. Cut framing members by sawing or shearing; do not torch cut. Provide members free of kinks and twists. Do not use damaged or distorted materials.
- R. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated on contract documents.

- S. Install supplementary framing, blocking, and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Use backing plates per the structural drawings to accommodate fastenings.
- T. Use pre-punched openings in the studs wherever possible to run 1½" outside diameter or smaller conduit or plumbing lines horizontally between studs. If penetrations are required in studs reinforce studs per the Steel Stud Manufacturer's Association (SSMA) requirements or refer to contract documents for stud reinforcing details. If reinforcing details are not specifically shown on the contract documents, reinforce stud penetrations per SSMA requirements.
- U. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of lath, sheathing, wallboard or other finishing materials.

3.03 CONNECTIONS TO METAL DECKING

- A. Provide premolded neoprene filler strips matching flute profile for non-fire-rated walls and partitions covered on one or both sides up to metal decking.
- B. Top runner track of fire-rated partitions shall be a minimum of 20 gage, unless noted otherwise, and attached to metal deck with required fasteners at spacing required for fire rating, but in no case over 16 inches on center. Areas above runner shall be friction fit with a minimum depth of 2-1/2 inches of 4 pounds per cubic foot density mineral wool insulation. A minimum of 1/2 inch of firestopping compound shall be installed to each side of mineral wool insulation for a one-hour system, and one inch of firestopping for a 2-hour system. Install required special tracks, angles, fasteners and strips of gypsum wallboard to provide required fire resistance rating.
- C. Proprietary fire-rated top tracks shall be installed in accordance with manufacturer's recommendations and fire rating approval requirements.

3.04 QUALITY CONTROL

- A. Welding Inspection:
 - 1. Inspection of field welding operations shall be performed by the special inspector. All inspection and testing shall be in compliance with CBC requirements.
 - 2. The special inspector shall inspect material, equipment, procedures, welds, and welder qualifications.

3.05 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

3.06 PROTECTION

- A. Protect Work of this section until Substantial Completion.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Alternating tread devices.
6. Metal ships' ladders and pipe crossovers.
7. Metal floor plate.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim.
11. Metal bollards.
12. Vehicular barrier cable systems.
13. Pipe and downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Cast-iron wheel guards.
16. Metal downspout boots.
17. Loose bearing and leveling plates.
18. Skateboard Deterrents.
19. Steel Cane Detection Rails.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

2. Section 05 12 00 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 07 72 00 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.02 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 ACTION SUBMITTALS

- A. Product Data:
 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 2. Fasteners.
 3. Shop primers.
 4. Shrinkage-resisting grout.
 5. Prefabricated building columns.
 6. Slotted channel framing.
 7. Manufactured metal ladders.
 8. Alternating tread devices.
 9. Metal ships' ladders and pipe crossovers.
 10. Metal bollards.
 11. Vehicular barrier cable systems.
 12. Pipe and downspout guards.
 13. Abrasive metal nosings, treads, and thresholds.
 14. Cast-iron wheel guards.
 15. Metal downspout boots.
- B. Shop Drawings: Show fabrication and installation details. [Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.] Provide Shop Drawings for the following:
 1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
 2. Elevator machine beams, hoist beams, and divider beams.
 3. Steel shapes for supporting elevator door sills.
 4. Steel girders for supporting wood frame construction.
 5. Steel pipe columns for supporting wood frame construction.

6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Alternating tread devices.
10. Metal ships' ladders and pipe crossovers.
11. Metal floor plate and supports.
12. Elevator pit sump covers.
13. Structural-steel door frames.
14. Miscellaneous steel trim including **[steel angle corner guards] [steel edgings] [and] [loading-dock edge angles]**.
15. Metal bollards.
16. Loose steel lintels.
17. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded **[nosing] [and] [tread]**.

D. Delegated Design Submittals: For **[ladders] [alternating tread devices] [and] [vehicular barrier cable systems]**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.06 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design **[ladders] [alternating tread devices] [and] [vehicular barrier cable systems]**.
- B. Structural Performance of Aluminum Ladders: Ladders **[, including landings,]** are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.
- C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform Load: 100 lbf/sq. ft..
 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 5. Comply with applicable railing loadings in Section 05 52 13 "Pipe and Tube Railings."
- D. Vehicular Barrier Cable Systems: Design vehicular barrier cable systems to resist a single **[6000-lbf] <Insert value>** service load and **[10,000-lbf] <Insert load>** ultimate load applied horizontally in any direction to the cable system, with anchorages or attachments capable of transferring this load to the structure. Limit deflection to 18 inches. Design is to assume loads are applied at a height of **[18 inches] <Insert height>** above the floor or ramp surface on an area not to exceed 1 sq. ft..
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.

2.02 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, **[Type 304] [Type 316L]**.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, **[Type 304] [Type 316L]**.
- E. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- F. Rolled-Stainless Steel Floor Plate: ASTM A793.

- G. Abrasive-Surface Floor Plate: Steel plate [with abrasive granules rolled into surface] [or] [with abrasive material metallurgically bonded to steel].
1. Source Limitations: Obtain floor plate from single source from single manufacturer.
- H. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Zinc-Coated Steel Wire Rope: ASTM A741.
1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- K. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.
1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- L. Steel Prestressing Strand: ASTM A416/A416M, Grade 270, low-relaxation, seven-wire, with 0.9-lb/sq. ft. zinc coating.
1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.
- M. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
1. Size of Channels: **[1-5/8 by 1-5/8 inches]** [As indicated] <Insert size>.
 2. Galvanized Steel: ASTM A653/A653M, **[commercial steel, Type B] [structural steel, Grade 33]**, with G90 coating; **[0.108-inch] [0.079-inch] [0.064-inch]** nominal thickness.
 3. Cold-Rolled Steel: ASTM A1008/A1008M, **[commercial steel, Type B] [structural steel, Grade 33]; [0.0966-inch] [0.0677-inch] [0.0528-inch]** minimum thickness; **[unfinished] [coated with rust-inhibitive, baked-on, acrylic enamel] [hot-dip galvanized after fabrication]**.
- N. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- O. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- P. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- Q. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- R. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- S. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
- T. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (lead red brass) or UNS No. C84400 (lead semired brass).
- U. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

- V. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.03 FASTENERS

- A. General: Unless otherwise indicated, provide **[Type 304]** **[Type 316]** stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
1. Provide stainless steel fasteners for fastening **[aluminum]** **[stainless steel]** **[or]** **[nickel silver]**.
 2. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy **[Group 1]** **[Group 2]**.
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- H. Post-Installed Anchors: **[Torque-controlled expansion anchors]** **[or]** **[chemical anchors]**.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group 1]** **[Group 2]** stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.04 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with [Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings."] [Section 09 91 13 "Exterior Painting," Section 09 91 23 "Interior Painting," and Section 09 96 00 "High-Performance Coatings."]
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.05 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing [**and contour of welded surface matches that of adjacent surface**].
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Fabricate supports for operable partitions from continuous steel beams of sizes [**indicated**] [**recommended by partition manufacturer**] with attached bearing plates, anchors, and braces as [**indicated**] [**recommended by partition manufacturer**]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
 1. Provide bearing plates welded to beams where indicated.
 2. Drill or punch girders and plates for field-bolted connections where indicated.
 3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.
- E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
 1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.

2. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.

F. Galvanize miscellaneous framing and supports where indicated.

G. Prime miscellaneous framing and supports with [zinc-rich primer] [primer specified in Section 09 96 00 "High-Performance Coatings"] where indicated.

2.07 PREFABRICATED BUILDING COLUMNS

A. Source Limitations: Obtain prefabricated building column from single source from single manufacturer.

B. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

C. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: **[4 hours] [3 hours] [2 hours] [As indicated]**.

2.08 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize [**and prime**] shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with [zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.09 METAL LADDERS

A. General:

1. Comply with ANSI A14.3 [, except for elevator pit ladders].

2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails **[16 inches] [18 inches]** apart unless otherwise indicated.

2. Siderails: Continuous, **[3/8-by-2-1/2-inch]** **[1/2-by-2-1/2-inch]** steel flat bars, with eased edges.
3. Rungs: **[3/4-inch-diameter]** **[3/4-inch-square]** **[1-inch-diameter]** **[1-inch-square]**, steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **[1/2 inch]** **[3/4 inch]** in least dimension.
9. Support each ladder **[at top and bottom and not more than 60 inches o.c.]** with welded or bolted steel brackets.
10. Galvanize **[and prime]** **[exterior]** ladders, including brackets.
11. Prime **[exterior]** ladders, including brackets and fasteners, with **[zinc-rich primer.]** **[primer specified in Section 09 96 00 "High-Performance Coatings."]**

C. Aluminum Ladders:

1. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
2. Space siderails **[16 inches]** **[18 inches]** apart unless otherwise indicated.
3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
5. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
6. Provide platforms as indicated fabricated from **[pressure-locked aluminum bar grating]** **[or]** **[extruded-aluminum plank grating]**, supported by extruded-aluminum framing. Limit openings in gratings to no more than **[1/2 inch]** **[3/4 inch]** in least dimension.
7. Support each ladder **[at top and bottom and not more than 60 inches o.c.]** with welded or bolted aluminum brackets.
8. Provide minimum 72-inch-high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.10 ALTERNATING TREAD DEVICES

- A. Alternating Tread Devices: Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Tread depth is not to be less than 5 inches exclusive of nosing or less than 8-1/2 inches, including the nosing, tread width is not to be less than 7 inches, and riser height is not to be more than 9-1/2 inches.
 2. Tread depth is not to be less than 8-1/2 inches exclusive of nosing or less than 10-1/2 inches, including the nosing, tread width is not to be less than 7 inches, and riser height is not to be more than 8 inches.
 3. Fabricate from **[steel] [stainless steel] [aluminum]** and assemble by welding or with stainless steel fasteners.
 4. Comply with applicable railing requirements in Section 05 52 13 "Pipe and Tube Railings."
- B. Galvanize **[and prime] [exterior]** steel alternating tread devices, including treads, railings, brackets, and fasteners.
- C. Prime **[exterior]** steel alternating tread devices, including treads, railings, brackets, and fasteners, with **[zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]**

2.11 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Provide metal **[ships' ladders] [and] [pipe crossovers]** where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
1. Treads are not to be less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height is not to be more than 9-1/2 inches.
 2. Fabricate **[ships' ladders] [and] [pipe crossovers]**, including railings from **[steel] [stainless steel] [aluminum]**.
 3. Fabricate treads **[and platforms]** from **[welded or pressure-locked steel bar] [pressure-locked stainless steel bar] [pressure-locked aluminum bar] [extruded-aluminum plank]** grating. Limit openings in gratings to no more than **[1/2 inch] [3/4 inch]** in least dimension.
 4. Fabricate treads **[and platforms]** from **[rolled-steel floor] [rolled-stainless steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor]** plate.
 5. Comply with applicable railing requirements in Section 05 52 13 "Pipe and Tube Railings."
- B. Galvanize **[and prime] [exterior]** steel **[ships' ladders] [and] [pipe crossovers]**, including treads, railings, brackets, and fasteners.
- C. Prime **[exterior]** steel **[ships' ladders] [and] [pipe crossovers]**, including treads, railings, brackets, and fasteners, with **[zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]**

2.12 METAL FLOOR PLATE

- A. Fabricate from **[rolled-steel floor] [rolled-stainless steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor]** plate of thickness indicated below:
1. Thickness: **[1/8 inch] [3/16 inch] [1/4 inch] [5/16 inch] [3/8 inch] [As indicated]**.

- B. Provide grating sections where indicated, fabricated from [welded or pressure-locked steel bar] [pressure-locked stainless steel bar] [pressure-locked aluminum bar] [extruded-aluminum plank] grating. Limit openings in gratings to no more than [1/2 inch] [3/4 inch] [1 inch] in least dimension.
- C. Provide [steel] [stainless steel] [aluminum] angle supports as indicated.
- D. Include [steel] [stainless steel] [aluminum] angle stiffeners, and fixed and removable sections as indicated.
- E. Provide flush [steel] [stainless steel] [aluminum] bar drop handles for lifting removable sections, one at each end of each section.

2.13 ELEVATOR PIT SUMP COVERS

- A. Fabricate from [1/8-inch] [3/16-inch] [rolled-steel] [abrasive-surface] floor plate with four 1-inch-diameter holes for water drainage and for lifting.
- B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than [1/2 inch] [3/4 inch] [1 inch] in least dimension.
- C. Provide steel angle supports unless otherwise indicated.

2.14 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
 - 1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
- C. Galvanize [and prime] [exterior] steel frames.
- D. Prime [exterior] steel frames with [zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]

1.2 MISCELLANEOUS STEEL TRIM

- E. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- F. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- G. Galvanize [and prime] [exterior] miscellaneous steel trim.

- H. Prime [exterior] miscellaneous steel trim with [zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]

2.15 METAL BOLLARDS

- A. Fabricate metal bollards from [Schedule 80 steel pipe] [Schedule 40 steel pipe] [Schedule 80 stainless steel, No. 4/180-grit finish] [**1/4-inch** wall-thickness rectangular steel tubing] [steel shapes, as indicated].
 1. Cap bollards with 1/4-inch-thick, [steel] [stainless steel, ASTM A480/A480M, No. 4 finish] plate with [flat] [sloped] [domed] top.
 2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Fabricate bollards with 3/8-inch-thick, [**steel**] [**stainless steel, ASTM A480/A480M, No. 4 finish**] baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
 1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
- C. Fabricate sleeves for bollard anchorage from steel or stainless steel [**pipe**] [**or**] [**tubing**] with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- D. Fabricate internal sleeves for removable bollards from Schedule 80 [**steel**] [**stainless steel**] pipe or 1/4-inch wall-thickness [**steel**] [**stainless steel**] tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch [**steel**] [**stainless steel**] machine bolt.
- E. Prime steel bollards with [zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]

2.16 VEHICULAR BARRIER CABLE SYSTEMS

- A. Vehicular Barrier Cable Systems: Of diameter required by performance requirements, but not less than 1/2-inch-diameter, [**zinc-coated steel wire rope**] [**stainless steel wire rope**] [**zinc-coated steel prestressing strand**] with turnbuckles, toggles, machine swage terminals, and other fittings and accessories for securing to structural columns and walls and for tightening barrier cable.

2.17 PIPE AND DOWNSPOUT GUARDS

- A. Fabricate [**pipe**] [**downspout**] guards from 3/8-inch-thick by 12-inch-wide, [**steel**] [**stainless steel, ASTM A480/A480M, No. 4 finish**] plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.
- B. Galvanize [**and prime**] steel [**pipe**] [**downspout**] guards.
- C. Prime steel [**pipe**] [**downspout**] guards with [zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]

2.18 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Cast-Metal Units: Cast **[iron] [aluminum] [bronze (leaded red or semired brass)] [nickel silver (leaded nickel bronze)]**, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
1. Source Limitations: Obtain units from single source from single manufacturer.
 2. Cross-hatched nosings, 4 inches wide, with 1/4-inch-thick 1-inch lip, for casting into concrete.
 3. Cross-hatched nosings, 1-1/2 inches wide, 3/8-inch-thick 1-1/2 inch lip, for casting into concrete.
 4. Cross-hatched Treads: Full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
 5. Fluted-Saddle-Type Thresholds: 5 inches wide by 1/2 inch high, with tapered edges.
 6. Fluted-Interlocking or -Hook-Strip Thresholds: 5 inches wide by 5/8 inch high, with tapered edge.
 7. Thresholds: Plain-stepped- (stop-) type units, 5 inches wide by 1/2 inch high, with 1/2-inch step.
- B. Extruded Units: **[Aluminum] [Bronze]**, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
1. Source Limitations: Obtain units from single source from single manufacturer.
 2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 3. Provide solid-abrasive-type units without ribs.
 4. Nosings:
 - a. Square-back units, **[1-7/8 inches] [3 inches] [4 inches]** wide, for casting into concrete steps.
 - b. Beveled-back units, **[3 inches] [4 inches]** wide with 1-3/8-inch lip, for surface mounting on existing stairs.
 - c. Two-piece units, 3 inches wide, with subchannel for casting into concrete steps.

5. Treads: **[Square] [Beveled]**-back units, full depth of tread with 1-3/8-inch lip, for application over existing stairs.
 - C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
 - D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
 1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.
 - E. Apply bituminous paint to concealed surfaces of cast-metal units.
 - F. Apply clear lacquer to concealed surfaces of extruded units.
- 2.19 CAST-IRON WHEEL GUARDS
- A. Provide wheel guards made from cast-iron, 3/4-inch-thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.
 - B. Prime cast-iron wheel guards with **[zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]**
- 2.20 METAL DOWNSPOUT BOOTS
- A. Source Limitations: Obtain downspout boots from single source from single manufacturer.
 - B. Provide downspout boots made from cast **[iron] [aluminum]** in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
 1. Outlet: **[Vertical, to discharge into pipe] [Horizontal, to discharge into pipe] [At 35 degrees from horizontal, to discharge onto splash block or pavement].**
 - C. Prime cast-iron downspout boots with **[zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]**
- 2.21 LOOSE BEARING AND LEVELING PLATES
- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
 - B. Galvanize bearing and leveling plates.
 - C. Prime plates with **[zinc-rich primer.] [primer specified in Section 09 96 00 "High-Performance Coatings."]**
- 2.22 LOOSE STEEL LINTELS
- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

- B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches unless otherwise indicated.
- C. Galvanize [**and prime**] loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with [**zinc-rich primer.**] [**primer specified in Section 09 96 00 "High-Performance Coatings."**]

2.23 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.24 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.25 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items [**not indicated to be galvanized**] unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with [**universal shop primer**] [**primers specified in Section 09 91 13 "Exterior Painting"**] [**primers specified in Section 09 91 23 "Interior Painting"**] **unless** [**zinc-rich primer is**] [**primers specified in Section 09 96 00 "High-Performance Coatings" are**] indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**] [**SSPC-SP 3, "Power Tool Cleaning."**] [**requirements indicated below:**]
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Items Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 - 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.26 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

2.27 SKATEBOARD DETERRENTS

- A. Acceptable manufacturers includes the following:
 - 1. Warehouse LLC,, Delray Beach Florida.
 - 2. Grind to a Halt, Elburn Illinois.
 - 3. Skate Stoppers, El Cajon California.
 - 4. The Park and Facilities, West Palm Beach Florida.
 - 5. Or equal.
- B. Material: Type 318 stainless steel.

2.28 STEEL CANE DETECTION RAILS

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for **[ceiling-hung toilet partitions] [operable partitions] [overhead doors] [and] [overhead grilles]** securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with **[expansion anchors] [anchor bolts] [through bolts]**.
- D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.03 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.04 INSTALLATION OF SHELF ANGLES

- A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.05 INSTALLATION OF METAL LADDERS

- A. Secure ladders to adjacent construction with the clip angles attached to the stringer.
- B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.06 INSTALLATION OF ALTERNATING TREAD DEVICES

- A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.

3.07 INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.
- B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

3.08 INSTALLATION OF METAL FLOOR PLATE

- A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.09 INSTALLATION OF ELEVATOR PIT SUMP COVERS

- A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.10 INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

- A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.11 INSTALLATION OF MISCELLANEOUS STEEL TRIM

- A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.12 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.
- B. Anchor bollards to existing construction with **[expansion anchors] [anchor bolts] [through bolts]**. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.
 - 1. Embed anchor bolts at least 4 inches in concrete.
- C. Anchor bollards in concrete **[with pipe sleeves preset and anchored into concrete] [in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of bollard]**. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

- E. Anchor internal sleeves for removable bollards in **[concrete by inserting in pipe sleeves preset into concrete] [formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of sleeve]**. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.
- F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- G. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.
- H. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.13 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

- A. Install vehicular barrier cable systems at locations indicated, mounted at heights indicated on Drawings above the parking surface. Anchor **[wire ropes] [steel prestressing strand]** to structural columns and walls and tension to withstand vehicle loading as specified in "Performance Requirements" Article with no cable tensioned less than 3000 lbf. Do not displace supporting components.

3.14 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

- A. Provide pipe guards at exposed vertical pipes in **[parking garage] [at locations indicated on Drawings]** where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch bolts at each pipe guard. Mount pipe guards with top edge 26 inches above driving surface.

3.15 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 07 92 00 "Joint Sealants" to provide a watertight installation.

3.16 INSTALLATION OF CAST-IRON WHEEL GUARDS

- A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.17 INSTALLATION OF METAL DOWNSPOUT BOOTS

- A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.
- B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.18 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.19 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in **[Section 09 91 13 "Exterior Painting."]** **[Section 09 91 23 "Interior Painting."]**
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

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SECTION 05 51 13

METAL PAN STAIRS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with **[concrete-filled] [precast concrete] [precast terrazzo] [epoxy-resin-filled] [and] [abrasive-coating-finished, formed-metal]** treads.
2. **[Steel tube] railings** and guards attached to metal stairs.
3. **[Steel tube] handrails** attached to walls adjacent to metal stairs.
4. Railing gates at the level of exit discharge.

1.02 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs **[, railings, and guards]**.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, **[blocking for attachment of wall-mounted handrails,]** and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.03 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Perforated metal.
2. Woven-wire mesh.
3. Welded-wire mesh.

4. Prefilled metal-pan-stair treads.
5. Abrasive nosings.
6. Shop primer products.
7. Nonslip-aggregate concrete finish.
8. Abrasive-coating finish to formed-metal stairs.
9. Precast concrete treads.
10. Precast terrazzo treads.
11. Epoxy-resin-filled stair treads.
12. Handrail wall brackets.
13. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.
5. Indicate profile and dimensions of precast terrazzo treads.
6. Indicate profile and dimensions of epoxy-resin-filled treads.

C. Samples for Verification: For each type and finish of **[nosing]** **[precast terrazzo tread]** **[epoxy-resin-filled tread]**.

D. Delegated Design Submittal: For stairs, **[railings and guards,]** **[precast terrazzo treads,]** **[epoxy-resin-filled treads]**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the **[jurisdiction]** **[State]** in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
 1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 2. Protect steel members and packaged materials from corrosion and deterioration.
 3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
 - a. Repair or replace damaged materials or structures as directed.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design stairs, **[railings and guards,] [precast terrazzo treads,] [epoxy-resin-filled treads]**, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Uniform Load: 100 lbf/sq. ft..
 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 5. Limit deflection of treads, platforms, and framing members to **[L/360] <Insert deflection ratio>** or 1/4 inch, whichever is less.
- C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** **<Insert temperature change>**.
- D. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]** **<Insert requirement>**.
 1. Component Importance Factor: **<Insert requirement>**.

2.02 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing for Railings and Guards: **[ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M]**.
 1. Provide galvanized finish for exterior installations and where indicated.
- D. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 1. Provide galvanized finish for exterior installations and where indicated.
- E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, **[either commercial steel, Type B, or]** structural steel, Grade 25, unless another grade is required by design loads; exposed.
- F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, **[either commercial steel, Type B, or]** structural steel, Grade 30, unless another grade is required by design loads.
- G. Galvanized Steel Sheet: ASTM A653/A653M, G90 coating, **[either commercial steel, Type B, or]** structural steel, Grade 33, unless another grade is required by design loads.
- H. Expanded-Metal, Carbon Steel: ASTM F1267, **[Type I (expanded)] [Type II (expanded and flattened)]**, Class 1 (uncoated).
 1. Style Designation: **[3/4 number 13] [1-1/2 number 10]** **<Insert designation>**.
- I. Perforated Metal, Uncoated: Cold-rolled steel sheet, ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, **[0.060 inch]** **<Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows] [with 1/8-by-1-inch round end slotted holes in staggered rows]** **<Insert description>**.
- J. Perforated Metal, Galvanized Steel Sheet: ASTM A653/A653M, G90 coating, commercial steel Type B, **[0.064 inch]** **<Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows]** **<Insert description>**.

- K. Perforated Metal, Aluminum Sheet: ASTM B209, **[0.125 inch] [0.063 inch]** <Insert dimension> thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows]** <Insert description>.
- L. Woven-Wire Mesh, Steel: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.135-inch nominal-diameter steel wire complying with ASTM A510/A510M.
- M. Woven-Wire Mesh, Aluminum: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.162-inch-diameter, aluminum wire complying with ASTM B211, Alloy 6061-T94.
- N. Welded-Wire Mesh: **[Diamond] [Square]** pattern, 2-inch welded-wire mesh, made from 0.236-inch nominal-diameter steel wire complying with ASTM A510/A510M.
- O. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- P. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- Q. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
- R. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).
- S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).
- T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.03 ABRASIVE NOSINGS

- A. Cast-Metal Units: Cast **[iron] [aluminum] [bronze] [nickel silver]**, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
 - 1. Configuration: Cross-hatched units, **[3 inches] [4 inches]** wide without lip.
- B. Extruded Units: **[Aluminum] [Bronze]** units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
 - 1. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 - 2. Provide solid-abrasive units without ribs.
 - 3. Nosings, Square-Back Units: **[1-7/8 inches] [3 inches] [4 inches]** wide, without lip.
 - 4. Nosings, Two-Piece Units: 3 inches wide, with subchannel for casting into concrete.
- C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- D. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.
- E. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.04 FASTENERS

- A. General: Provide [zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5] [Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5] where built into exterior walls.
1. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated [**and capable of withstanding design loads**].
- C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**] [**stairs indicated to be galvanized**] [**stairs indicated to be shop primed with zinc-rich primer**].
- E. Post-Installed Anchors: [**Torque-controlled expansion anchors**] [**or**] [**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1**] [**Group 2**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.05 MISCELLANEOUS MATERIALS

- A. Handrail Wall Brackets: [Cast nickel-silver,] [Cast aluminum,] [Cast bronze,] [Cast stainless steel,] center of rail [**2-1/2 inches**] [**3-1/8 inches**] <Insert dimension> from face of wall.
- B. Welding Electrodes: Comply with AWS requirements.
- C. Shop Primers: Provide primers that comply with [Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings."] [Section 09 91 13 "Exterior Painting," Section 09 91 23 "Interior Painting," and Section 09 96 00 "High-Performance Coatings."]
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- E. Zinc-Rich Primer: Comply with SSPC-Paint 20, [**Type I-A**] [**Type I-B**] [**Type I-C**] [**Type II**], Level [**1**] [**2**] [**3**], and compatible with topcoat.

- F. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish system indicated.
- G. Galvanizing Repair Paint: High-zinc-dust-content paint complying with **[SSPC-Paint 20]** **[ASTM A780/A780M]** and compatible with paints specified to be used over it.
- H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- I. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for **[interior]** **[exterior]** use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.
- J. Prefilled Concrete Treads:
 - 1. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with minimum 28-day compressive strength of 3000 psi and maximum aggregate size of 1/2 inch unless otherwise indicated.
 - 2. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
 - 3. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, **[steel,]** **[galvanized steel,]** 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated on Drawings.
 - 4. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening welded-wire reinforcement in place.
 - a. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.
- K. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.06 PRECAST CONCRETE TREADS

- A. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi and a total air content of not less than 4 percent or more than 6 percent.
- B. Reinforcement: Galvanized, welded-wire reinforcement, 2 by 2 inches by 0.062-inch-diameter steel wire; comply with ASTM A1064/A1064M, except for minimum wire size.

2.07 PRECAST TERRAZZO TREADS

- A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.
 - 1. Epoxy Resin Matrix: Manufacturer's standard recommended for use indicated.

2. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.
 - a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.
3. Reinforcement: ASTM A615/A615M, Grade 60 bars, as required by unit size, profile, and thickness.
4. Abrasive Inserts: 1/2-inch-wide, silicon carbon/epoxy mixture.
 - a. Provide three inserts, 1/2 inch apart, with first insert located 1 inch from nosing at adjacent stair riser locations.
5. Color: As selected by Architect from manufacturer's standard color selections.
6. Finish: Honed.
7. Surface Sealer: Slip- and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 8; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.08 EPOXY-RESIN-FILLED TREADS

- A. Epoxy-Resin-Filled Treads: 3/8-inch-thick, epoxy resin with 8000-psi compressive strength; set on steel subthead.
 1. Color: As selected by Architect from manufacturer's standard color selections.

2.09 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, **[railings and guards,]** clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 1. Join components by welding unless otherwise indicated.
 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs **[, railings, and guards]** in shop to greatest extent possible.
 1. Disassemble units only as necessary for shipping and handling limitations.
 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 2. Remove sharp or rough areas on exposed surfaces.

- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for **[Finish #1 - No evidence of welded joint] [Finish #2 - Completely sanded joint with some undercutting and pinholes okay] [Finish #3 - Partially dressed weld with spatter removed] [Finish #4 - Good quality, uniform undressed weld with minimal splatter]**.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that will be exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.10 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for **[Architectural] [Commercial] [Service]** Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Stringers: Fabricate of **[steel plates] [or] [steel channels] [or] [steel rectangular tubes] [as indicated on Drawings]**.
 - a. Stringer Size: **[As required to comply with "Performance Requirements" Article] [As indicated on Drawings]**.
 - b. Provide closures for exposed ends of channel and rectangular tube stringers.
 - c. Finish: **[Shop primed] [Painted] [Galvanized]**.
 - 2. Platforms: Construct of **[steel plate] [or] [steel channel] [or] [steel rectangular tube]** headers and miscellaneous framing members as **[required to comply with "Performance Requirements" Article] [indicated on Drawings]**.
 - a. Provide closures for exposed ends of channel and rectangular tube framing.
 - b. Finish: **[Shop primed] [Painted] [Galvanized]**.

3. Weld **[or bolt]** stringers to headers; weld **[or bolt]** framing members to stringers and headers. **[If using bolts, fabricate and join so bolts are not exposed on finished surfaces.]**
 4. Where stairs are enclosed by gypsum board **[shaft-wall]** assemblies, provide hanger rods or struts to support landings from floor construction above or below.
 - a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
 5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.
1. Fabricate treads and landing subplatforms of exterior stairs so finished walking surfaces slope to drain.
 2. Steel Sheet, Uncoated: **[Cold] [Hot]-**rolled steel sheet **[unless otherwise indicated].**
 3. Galvanized Steel Sheet: Galvanized steel sheet **[, where indicated].**
 4. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
 5. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
 6. Shape metal pans to include nosing integral with riser.
 7. Attach abrasive nosings to risers.
 8. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
 9. Provide epoxy-resin-filled treads, reinforced with glass fibers, with non-slip-concrete aggregate finish to tread surface.
 10. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
 - a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.
- D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.097 inch.
1. Steel Sheet: Uncoated, hot-rolled steel sheet unless otherwise indicated.
 2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
 3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
 4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.11 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Comply with applicable requirements in [Section 05 52 13 "Pipe and Tube Railings."] [Section 05 73 00 "Decorative Metal Railings."]
- B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
1. Rails and Posts: **[1-5/8-inch-diameter] [1-1/2-inch-square]** top and bottom rails and 1-1/2-inch-square posts.
 2. Picket Infill: **[1/2-inch-] [3/4-inch-] [round] [square]** pickets spaced to prohibit the passage of a 4-inch diameter sphere.
 3. Expanded-Metal Infill: Expanded-metal panels edged with U-shaped channels made from steel sheet and not less than 0.043 inch thick. Orient expanded metal with long dimension of diamonds **[parallel to top rail] [perpendicular to top rail] [vertical]**.
 4. Perforated-Metal Infill: Perforated-metal panels edged with U-shaped channels made from metal sheet, of same metal as perforated metal, and not less than 0.043 inch thick. Orient perforated metal with pattern **[parallel to top rail] [perpendicular to top rail] [horizontal] [vertical] [as indicated on Drawings]**.
 5. Mesh Infill: **[Woven] [Welded]**-wire mesh crimped into 1-by-1/2-by-1/8-inch steel channel frames. Orient wire mesh with **[diamonds vertical] [wires perpendicular and parallel to top rail] [wires horizontal and vertical]**.
 6. Intermediate Rails Infill: **[1-5/8-inch-diameter] [1-1/2-inch-square]** intermediate rails spaced less than **[12 inches] [21 inches]** clear.
 7. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with **[cam-type, self-closing] [spring]** hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.
- C. Welded Connections: Fabricate railings and guards with welded connections.
1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 3. Weld all around at connections, including at fittings.
 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 5. Obtain fusion without undercut or overlap.
 6. Remove flux immediately.
 7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for **[Finish #1 - No evidence of a welded joint] [Finish #2 - Completely sanded joint, some undercutting and pinholes are okay] [Finish #3 - Partially dressed weld with spatter removed] [Finish #4 - Good quality, uniform undressed weld with minimal splatter]** as shown in NAAMM AMP 521.
- D. Form changes in direction of railings and guards as follows:

1. As detailed.
 2. By bending **[or by inserting prefabricated elbow fittings]**.
 3. By flush bends **[or by inserting prefabricated flush-elbow fittings]**.
 4. By radius bends of radius indicated **[or by inserting prefabricated elbow fittings of radius indicated]**.
 5. By inserting prefabricated **[elbow fittings] [flush-elbow fittings] [elbow fittings of radius indicated]**.
- E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- F. Close exposed ends of railing and guard members with prefabricated end fittings.
- G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
1. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- H. Connect posts to stair framing by direct welding unless otherwise indicated.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
 4. Provide type of bracket **[with flange tapped for concealed anchorage to threaded hanger bolt] [with predrilled hole for exposed bolt anchorage]** and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.
- J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.
1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.12 FINISHES

- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
 1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF METAL PAN STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
 1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
 1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.
 - a. Clean bottom surface of plates.
 - b. Set plates for structural members on wedges, shims, or setting nuts.
 - c. Tighten anchor bolts after supported members have been positioned and plumbed.
 - d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.
 - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
 - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 - 3. Comply with requirements for welding in "Fabrication, General" Article.
- F. Place and finish concrete fill for treads and platforms to comply with Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Install abrasive nosings with anchors fully embedded in concrete.
 - 2. Center nosings on tread width.
- G. Install precast concrete treads with adhesive supplied by manufacturer.
- H. Install precast terrazzo treads according to manufacturer's written instructions.

3.03 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 - 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 - 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
 - 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by **[welding] [or] [bolting]** to steel supporting members.
 - b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.
- B. Install railing gates level, plumb, and secure for full opening without interference.
 - 1. Attach hardware using tamper-resistant or concealed means.
 - 2. Adjust hardware for smooth operation.
- C. Attach handrails to wall with wall brackets.
 - 1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 2. Secure wall brackets to building construction as **[required to comply with performance requirements.] [follows:]**
 - a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

- b. For hollow masonry anchorage, use toggle bolts.
- c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
- d. For steel-framed partitions, use hanger or lag bolts set into **[fire-retardant-treated] wood** backing between studs. Coordinate with stud installation to locate backing members.
- e. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
- f. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.04 REPAIR

A. Touchup Painting:

- 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 00 "Painting" and Section 09 96 00 "High-Performance Coatings."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

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SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel railings.
2. Aluminum railings.
3. Stainless steel railings.

B. Related Requirements:

1. Section 05 51 13 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.
2. Section 05 73 00 "Decorative Metal Railings" for ornamental railings fabricated from pipes and tubes and guard-infill metals.
3. Section 09 69 00 "Access Flooring" for railings included with access flooring.

1.02 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of mechanically connected railings.
2. Expanded metal infill panels.
3. Perforated metal infill panels.
4. Woven-wire mesh infill panels.
5. Fasteners.
6. Post-installed anchors.
7. Handrail brackets.

8. Shop primer.
 9. Intermediate coats and topcoats.
 10. Bituminous paint.
 11. Nonshrink, nonmetallic grout.
 12. Anchoring cement.
 13. Metal finishes.
 14. Paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design **[, including mechanical finishes]**.
- D. Samples for Verification: For each type of exposed finish required.
1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
 2. Fittings and brackets.
 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of **[connecting] [and] [finishing]** members at intersections.
- E. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For **[delegated design professional engineer] [testing agency]**.
- B. Welding certificates.
- C. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- F. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
- 1.05 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.07 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces] <Insert temperature change>**.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage]** and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.03 STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Tubing: **[ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M, Type 5]**.
- C. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 1. Provide galvanized finish for exterior installations and where indicated.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.
- E. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- F. Expanded Metal Infill Panels: ASTM F1267, **[Type I (expanded)] [Type II (expanded and flattened)]**, Class 1 (uncoated).
 1. Style Designation: **[3/4 number 13] [1-1/2 number 10] <Insert designation>**.
- G. Perforated-Metal Infill Panels:
 1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel, Type B, **[0.060 inch] <Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows] <Insert description>**.
 - a. Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.
 2. Galvanized-Steel Sheet: ASTM A653/A653M, G90 coating, commercial steel Type B, **[0.064 inch] <Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows] [with 1/8-by-1-inch round end slotted holes in staggered rows] <Insert description>**.
 - a. Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.
- H. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.134-inch-diameter steel wire complying with ASTM A510.
 1. Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

2.04 ALUMINUM RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- C. Extruded Bars and Tubing: ASTM B221, Alloy 6063-T5/T52.
- D. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
 - 1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- E. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.
- F. Plate and Sheet: ASTM B209, Alloy 6061-T6.
- G. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- H. Castings: ASTM B26/B26M, Alloy A356.0-T6.
- I. Perforated Metal Infill Panels: Aluminum sheet, ASTM B209, Alloy 6061-T6, **[0.063 inch]** <Insert dimension> thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows]** <Insert description>.
 - 1. Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings]** <Insert manufacturer's name; product name or designation>.
- J. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond]** **[square]** pattern, 2-inch woven-wire mesh, made from 0.162-inch-diameter aluminum wire complying with ASTM B211/B211M, Alloy 6061-T94.
 - 1. Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings]** <Insert manufacturer's name; product name or designation>.

2.05 STAINLESS STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Tubing: ASTM A554, **[Grade MT 304]** **[Grade MT 316L]**.
- C. Pipe: ASTM A312/A312M, **[Grade TP 304]** **[Grade TP 316L]**.
- D. Castings: ASTM A743/A743M, **[Grade CF 8 or CF 20]** **[Grade CF 8M or CF 3M]**.
- E. Plate and Sheet: ASTM A240/A240M or ASTM A666, **[Type 304]** **[Type 316L]**.
- F. Expanded Metal Infill Panels: ASTM F1267, **[Type I (expanded)]** **[Type II (expanded and flattened)]**, Class 3 (corrosion-resistant steel), made from stainless steel sheet, ASTM A240/A240M or ASTM A666, **[Type 304]** **[Type 316]**.
 - 1. Style Designation: **[3/4 number 13]** **[1-1/2 number 10]** <Insert designation>.

- G. Perforated Metal Infill Panels: Stainless steel sheet, ASTM A240/A240M or ASTM A666, [Type 304] [Type 316L], **[0.062 inch]** <Insert dimension> thick, [with **1/4-inch** holes **3/8 inch** o.c. in staggered rows] <Insert description>.
1. Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings]** <Insert manufacturer's name; product name or designation>.
- H. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond]** **[square]** pattern, 2-inch woven-wire mesh, made from 0.141-inch-diameter stainless steel wire complying with ASTM A580/A580M, **[Type 304]** **[Type 316]**.
1. Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings]** <Insert manufacturer's name; product name or designation>.

2.06 FASTENERS

A. Fastener Materials:

1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for zinc coating.
2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
3. Aluminum Railing Components: **[Type 304]** **[Type 316]** stainless steel fasteners.
4. Stainless Steel Railing Components: **[Type 304]** **[Type 316]** stainless steel fasteners.
5. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction **[and capable of withstanding design loads]**.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
3. Provide **[Phillips]** **[tamper-resistant]** **[square or hex socket]** flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 **[or ICC-ES AC308]**.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group 1]** **[Group 2]** stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.07 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: [Cast iron] [Cast aluminum,] [Cast stainless steel,] [Cast nickel-silver,] center of handrail **[2-1/2 inches]** **[3-1/8 inches]** <Insert dimension> from [face of railing] [wall].
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
1. For **[aluminum]** **[and]** **[stainless steel]** railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Shop Primers: Provide primers that comply with [Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings."]
- F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- G. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- H. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- I. Intermediate Coats and Topcoats: Provide products that comply with [Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings."]
- J. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- K. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- L. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.
- M. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- N. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
1. Water-Resistant Product: **[At exterior locations]** **[and]** **[where indicated on Drawings]**, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.08 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage [**but not less than that required to support structural loads**].
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with [**welded**] [**or**] [**nonwelded**] connections unless otherwise indicated.
- H. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with [**cam-type, self-closing**] [**spring**] hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.
- I. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 welds; ornamental quality with no evidence of a welded joint**] [**Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay**] [**Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed**].
- J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

- K. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.
- L. Form changes in direction as follows:
1. As detailed.
 2. **[By bending] [or] [by inserting prefabricated elbow fittings].**
 3. **[By flush bends] [or] [by inserting prefabricated flush-elbow fittings].**
 4. **[By radius bends of radius indicated] [or] [by inserting prefabricated elbow fittings of radius indicated].**
 5. By bending to smallest radius that will not result in distortion of railing member.
- M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 2. Coordinate anchorage devices with supporting structure.
- R. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
1. Provide socket covers designed and fabricated to resist being dislodged.
 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- T. Expanded-Metal Infill Panels: Fabricate infill panels from expanded-metal sheet of same metal as railings.

1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch thick.
 2. Orient expanded metal with long dimension of diamonds **[parallel to top rail]** **[perpendicular to top rail]** **[horizontal]** **[vertical]**.
- U. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from **[steel]** **[galvanized steel]** **[aluminum]** **[stainless steel]** **[same metal as railings in which they are installed]**.
1. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch thick.
 2. Orient perforated metal with pattern **[parallel to top rail]** **[perpendicular to top rail]** **[horizontal]** **[vertical]** **[as indicated on Drawings]**.
- V. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch metal channel frames.
1. Fabricate wire mesh and frames from same metal as railings in which they are installed.
 2. Orient wire mesh with **[diamonds vertical]** **[diamonds perpendicular to top rail]** **[wires perpendicular and parallel to top rail]** **[wires horizontal and vertical]** **[as indicated on Drawings]**.
- W. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.09 STEEL AND IRON FINISHES

- A. Galvanized Railings:
1. Hot-dip galvanize **[exterior]** **[indicated]** steel railings, including hardware, after fabrication.
 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner **[and as follows]**.
1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with **[SSPC-SP 6/NACE No. 3.] [SSPC-SP 3.] [requirements indicated below:]**
1. Exterior Railings: SSPC-SP 6/NACE No. 3.
 2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
 3. Railings Indicated To Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
 4. Other Railings: SSPC-SP 3.
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
1. Shop prime uncoated railings with **[universal shop primer] [primers specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting"]** unless **[zinc-rich primer is] [primers specified in Section 09 96 00 "High-Performance Coatings" are]** indicated.
 2. Do not apply primer to galvanized surfaces.
- G. Shop-Painted Finish: Comply with **[Section 09 91 13 "Exterior Painting."] [Section 09 96 00 "High-Performance Coatings.]**
1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].**
- H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.
1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].**

2.10 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Mill Finish: AA-M12, nonspecular as fabricated.
- C. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41] [AA-M12C22A31].**
- D. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44] [AA-M12C22A32/A34].**
1. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].**

- E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- G. Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- H. Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- I. Single-Coat Superior Performance FEVE Organic Finish: Single-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish, complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- J. Two-Coat Superior Performance FEVE Organic Finish: Two-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

2.11 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces.
 - 3. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Pipe and Tubing Finishes:
 - 1. 180-Grit Polished Finish: Uniform, directionally textured finish.
 - 2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 - 3. Polished and Buffed Finish: 320-grit finish followed by buffing **[to a high luster finish] [to a mirror-like finish] [to match Architect's sample]**.
- D. Stainless Steel Sheet and Plate Finishes:
 - 1. Directional Satin Finish: ASTM A480/A480, No. 4.
 - 2. High-Luster Finish: ASTM A480/A480M, No. 7.
 - 3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

3.04 ANCHORING POSTS

- A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, **[welded to post after placing anchoring material] [attached to post with setscrews]**.
- D. Leave anchorage joint exposed with **[1/8-inch buildup, sloped away from post] [anchoring material flush with adjacent surface]**.
- E. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.
 - 2. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.
 - 3. For stainless steel railings, weld flanges to post and bolt to supporting surfaces.

- F. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.05 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with **[sleeves concealed within] [flanges connected to] [brackets on underside of rails connected to]** railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and **[welded to railing ends] [or] [connected to railing ends, using nonwelded connections]**.
- C. Attach handrails to walls with wall brackets **[, except where end flanges are used]**. Provide brackets with **[1-1/2-inch] <Insert dimension>** clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage]**.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets **[and railing end flanges]** to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.
 - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
 - 4. For steel-framed partitions, use hanger or lag bolts set into **[fire-retardant-treated]**wood backing between studs. Coordinate with stud installation to locate backing members.
 - 5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.
 - 6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.
- E. Install railing gates level, plumb, and secure for full opening without interference.
 - 1. Attach hardware using tamper-resistant or concealed means.
 - 2. Adjust hardware for smooth operation.

3.06 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

- a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in **[Section 09 91 13 "Exterior Painting.]"** **[Section 09 91 23 "Interior Painting.]"** **[Section 09 96 00 "High-Performance Coatings.]"**

3.07 CLEANING

- A. Clean **[aluminum]** **[and]** **[stainless steel]** by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.08 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05 70 00
DECORATIVE METAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Decorative window security bars.
2. Decorative mechanical grilles and frames.
3. Custom door pulls.
4. Combination hall push-button stations.
5. Metal reveals at wood paneling.
6. Cast-metal rosettes at marble joints.

B. Related Requirements:

1. Section 05 73 00 "Decorative Metal Railings" for decorative metal railings.
2. Section 05 75 00 "Decorative Formed Metal" for decorative metal items made from sheet metal.

1.02 COORDINATION

- A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product, including finishing materials.

1.

- B. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

- C. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

- D. Samples for Initial Selection: For products involving selection of color, texture, or design **[including mechanical finishes]**.

- E. Samples for Verification: For each type of exposed finish.
 - 1. Sections of linear shapes.
 - 2. Full-size Samples of castings and forgings.
 - a. For custom castings, submit finished Samples showing ability to reproduce detail [**cast-metal color,**] and quality of finish. [**Samples may be of similar previous work.**]
 - 3. Samples of [welded] [and] [brazed] joints showing quality of workmanship [and color matching of materials].

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [fabricator] [organic-coating applicator] [anodic finisher] [powder-coating applicator].
- B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.
- C. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Installer Qualifications: Fabricator of products.
- C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
- D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
- E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
- F. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 - 4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.07 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups for the following types of decorative metal:

- a. <Insert, in separate subparagraphs, description of each decorative metal type including mockup size>.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
 - B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.
- 1.09 FIELD CONDITIONS
- A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 PRODUCTS

2.01 DECORATIVE METAL FABRICATORS

- A. Fabricator: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 1. <Insert manufacturer's name>.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.03 ALUMINUM

- A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
- B. Bars and Shapes: ASTM B221, Alloy 6063-T5/T52.
- C. Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
- D. Tubing: ASTM B210, Alloy 6063-T832.
- E. Plate and Sheet: ASTM B209, [Alloy 3003-H14] [Alloy 5005-H32] [Alloy 6061-T6].
- F. Forgings: ASTM B247, Alloy 6061-T6.
- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.04 COPPER AND COPPER ALLOYS

- A. Fabricate products from alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2.05 BRONZE

- A. Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).
- B. Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).
- C. Tube: ASTM B135, Alloy UNS C23000 (red brass, 85 percent copper).
- D. Castings: [ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)] [or] [ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)].
- E. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

2.06 BRASS

- A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).
- B. Seamless Tube: ASTM B135, Alloy UNS C26000 (cartridge brass, 70 percent copper).
- C. Castings: ASTM B584, Alloy UNS C85200 (high-copper yellow brass).
- D. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

2.07 NICKEL SILVER

- A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.
- B. Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

2.08 COPPER

- A. Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).
- B. Castings: ASTM B824, with a minimum of 99.9 percent copper.
- C. Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.09 STAINLESS STEEL

- A. Tubing: ASTM A554, [Grade MT 304] [Grade MT 316] [Grade MT 316L].
- B. Pipe: ASTM A312/A312M, [Grade TP 304] [Grade TP 316] [Grade TP 316L].
- C. Castings: ASTM A743/A743M, [Grade CF 8 or Grade CF 20] [Grade CF 8M or Grade CF 3M].

- D. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, **[Type 304]** **[Type 316]** **[Type 316L]**.
- E. Flat Bar: ASTM A666, [Type 304] [Type 316] [Type 316L].
- F. Bars and Shapes: ASTM A276, [Type 304] [Type 316] [Type 316L].
- G. Wire Rope and Fittings:
 1. Wire Rope: **[1-by-19]** **[7-by-7]** **[7-by-19]** **<Insert designation>** wire rope made from wire complying with ASTM A492, Type 316.
 2. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain without failure a load equal to minimum breaking strength of wire rope with which they are used.

2.10 STEEL AND IRON

- A. Tubing: **[ASTM A500/A500M (cold formed)]** **[or]** **[ASTM A513, Type 5 (mandrel drawn)]**.
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- C. Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M unless otherwise indicated.
- E. Steel Sheet, Cold Rolled: ASTM A1008/A1008M, either commercial steel or structural steel, exposed.

2.11 TITANIUM

- A. Strip, Sheet, and Plate: ASTM B265, Grade 1.
- B. Bars: ASTM B348, Grade 1.

2.12 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 1. Aluminum Items: **[Aluminum]** **[Type 304 stainless steel]** **[Type 316 stainless steel]** fasteners.
 2. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed, muntz metal (Alloy 280) fasteners where exposed]**.
 3. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed, brass (Alloy 260 or 360) fasteners where exposed]**.
 4. Stainless Steel Items: **[Type 304]** **[Type 316]** stainless steel fasteners.
 5. Titanium Items: **[Type 304]** **[Type 316]** stainless steel fasteners.
 6. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless steel fasteners where exposed.
 7. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.

8. Dissimilar Metals: **[Type 304] [Type 316]** stainless steel fasteners.
 - B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
 - C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless **[otherwise indicated] [exposed fasteners are unavoidable]**.
 1. Provide **[Phillips] [tamper-resistant] [square or hex socket]** flat-head machine screws for exposed fasteners unless otherwise indicated.
 - D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 **[or ICC-ES AC308]**.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5 unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group 1] [Group 2]** stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- 2.13 MISCELLANEOUS MATERIALS
- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
 - B. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
 - C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
 - D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
 - E. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
 - F. Shop Primers: Provide primers that comply with **[Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings.]**
 - G. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
 - H. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
 - I. Shop Primer for Galvanized Steel: **[Cementitious galvanized metal primer complying with MPI#26] [Vinyl wash primer complying with MPI#80] [Water-based galvanized metal primer complying with MPI#134]**.
 - J. Intermediate Coats and Topcoats for Steel: Provide products that comply with **[Section 09 91 13 "Exterior Painting."] [Section 09 91 23 "Interior Painting."] [Section 09 96 00 "High-Performance Coatings.]**

- K. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
- L. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
- M. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.14 FABRICATION, GENERAL

- A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
 - 3. Use connections that maintain structural value of joined pieces.
- B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged.
 - 1. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes.
 - 2. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
- C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
- H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
- J. Comply with AWS for recommended practices in shop **[welding] [and] [brazing]. [Weld] [and] [brazed] behind finished surfaces without distorting or discoloring exposed side. Clean exposed [welded] [and] [brazed] joints of flux, and dress exposed and contact surfaces.**
 - 1. Where **[welding] [and] [brazing]** cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for **[Type 1 Welds: no evidence of a welded joint] [Type 2 Welds: completely sanded joint, some**

undercutting and pinholes okay] [Type 3 Welds: partially dressed weld with spatter removed] [Type 4 Welds: good quality, uniform undressed weld with minimal splatter].

- K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.15 FABRICATION OF DECORATIVE WINDOW SECURITY BARS

- A. Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.
- B. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.
- C. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.
1. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
 2. Fabricate anchorage devices that are capable of withstanding loads indicated.

2.16 DECORATIVE MECHANICAL GRILLES

- A. Fabricate decorative grilles from perforated **[aluminum] [brass] [bronze] [stainless steel] [steel]** sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.
1. Form perforations to match existing grilles.
 2. Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by Architect.
- B. Drill and countersink grilles for mounting screws at 2 inches from corners and at 10 inches or less o.c. Provide units with oval-head **[wood] [self-tapping machine]** screws.
- C. Fabricate grille frames from extruded **[aluminum] [brass] [bronze] [stainless steel] [steel]** of profiles and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates **[welded] [brazed]** to back of frames.
1. Secure grilles in frames with 0.5-inch-long **[welds] [brazing]** along perimeter of grilles at 4 inches o.c.
 2. Provide frame profiles to match existing frames.
 3. Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by Architect.
- D. Drill and countersink frames for mounting screws at 4 inches from corners and at 16 inches or less o.c. Provide units with oval-head **[wood] [self-tapping machine]** screws.

2.17 FABRICATION OF CUSTOM DOOR PULLS

- A. Fabricate custom door pulls from **[brass] [bronze] [stainless steel]** bar stock of profile indicated, fabricated to shapes indicated.
1. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces.
 2. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile.
 3. Drill and tap door pulls to receive through bolts for attachment to doors.
- B. Fabricate backing plates for custom door pulls from 1/8-inch **[brass] [bronze] [stainless steel]** sheet.
1. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal.
 2. Drill and countersink holes where indicated for screws and bolts.
- C. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

2.18 FABRICATION OF COMBINATION HALL PUSH-BUTTON STATIONS

- A. Fabricate units of **[brass] [bronze] [stainless steel]** to comply with details indicated. Coordinate with elevator signal equipment to provide integrated, closely fitted assemblies.
1. Fabricate faceplates from 1/8-inch-thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.
 2. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4-inch wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 10 by 10 by 3-1/2 inches in depth.
 3. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1/16 inch with engraving painted red. Make signs 5 inches wide by 8 inches high.
 4. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station **[, card reader,]** and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

2.19 FABRICATION OF METAL REVEALS

- A. Fabricate metal reveals for wood paneling from **[3/4-by-3/4-by-1/16-inch extruded-bronze] [3/4-by-3/4-by-0.025-inch brake-formed, stainless steel] [3/4-by-3/4-by-0.015-inch brake-formed titanium]** channels.
1. Drill for mounting screws 6 inches from ends of channels and not more than 24 inches o.c.
 2. Locate mounting screws at same heights for all channels.
 3. Provide **[black-finished,]** hex-socket, wafer-head screws for mounting reveals.

2.20 FABRICATION OF CAST-METAL ROSETTES

- A. Fabricate cast-metal rosettes to design indicated from **[aluminum]** **[brass]** **[bronze]** **[nickel silver]**. Drill and tap castings for threaded mounting studs.
1. Provide custom castings to match design indicated.
 2. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as judged solely by Architect.
 3. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by Architect.

2.21 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.22 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm]** **[AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm]** **[AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
1. Color: **[Champagne]** **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** <Insert color>.
 2. **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]**.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.
- E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]**.
- F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

- G. Superior-Performance Organic Finish: **[Two] [Three] [Four]**-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.23 COPPER-ALLOY FINISHES

- A. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
- B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
- C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
- D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
- E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
- F. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below):
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- G. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below):
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- H. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below):
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- I. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below):
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide) **[, with color matching Architect's sample]**.

- K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate) **[, with color matching Architect's sample].**
- L. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below) **[, with color matching Architect's sample]:**
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- M. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air dried; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below) **[, with blackening and buffing matching Architect's sample]:**
1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.

2.24 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1. Run grain of directional finishes with long dimension of each piece.
- C. Stainless Steel Tubing Finishes:
1. 180-Grit Polished Finish: Uniform, directionally textured finish.
 2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 3. Polished and Buffed Finish: 320-grit finish followed by buffing [to a high luster finish] [to a mirror-like finish] [to match Architect's sample].
- D. Stainless Steel Sheet and Plate Finishes:
1. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.
 2. Directional Satin Finish: ASTM A480/A480M, No. 4.
 3. Dull Satin Finish: ASTM A480/A480M, No. 6.
 4. High Luster Finish: ASTM A480/A480M, No. 7.
 5. Mirror Finish: ASTM A480/A480M, No. 8.
- E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- F. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.
- G. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.

1. Product: Subject to compliance with requirements, provide INCO colored stainless steel finish as developed and licensed by International Nickel Co., Ltd.
2. Color: [Match Architect's sample] [As selected by Architect from finisher's full range].

2.25 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.
 1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
 2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- C. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."] [SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."] [requirements indicated below:]
 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
- D. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 1. Shop prime uncoated ferrous-metal surfaces with **[universal shop primer] [primers specified in Section 09 90 00 "Painting"]** unless **[zinc-rich primer is]** primers specified in Section 09 96 00 "High-Performance Coatings" are indicated.
 2. Do not apply primer to galvanized surfaces.
- E. Shop-Painted Finish: Comply with [Section 09 90 00 "Painting."] [Section 09 96 00 "High-Performance Coatings."]
 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].
- F. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].
- G. Powder-Coat Finish, Nongalvanized: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
 1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.
 4. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].
- H. Powder-Coat Finish, Galvanized: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
 2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.
 4. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

2.26 TITANIUM FINISHES

- A. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
- B. Dull Matte Finish: Pickled and annealed.
- C. Bright Matte Finish: Vacuum annealed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
- B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

- D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
 - E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
 - F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
 - 1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
 - G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.
 - I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- 3.03 INSTALLATION OF DECORATIVE WINDOW SECURITY BARS
- A. Fasten security bar frames to concrete and masonry walls with cast-in-place or post-installed anchors. Peen exposed threads of anchors to prevent removal of security bars.
- 3.04 INSTALLATION OF DECORATIVE MECHANICAL GRILLES
- A. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.
 - 1. Secure to framing and blocking with specified fasteners.
 - 2. On marble, brick, and other solid surfaces, secure with wood screws in plastic plugs.
- 3.05 INSTALLATION OF DECORATIVE-METAL-CLAD, HOLLOW-METAL DOORS AND FRAMES
- A. Install doors and frames to comply with requirements specified in Section 08 11 13 "Hollow Metal Doors and Frames."
- 3.06 INSTALLATION OF CUSTOM DOOR PULLS
- A. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head **[wood]** **[self-tapping metal]** screws and secure pulls through doors and backing plates with oval-head machine screws.

3.07 INSTALLATION OF COMBINATION HALL PUSH-BUTTON STATIONS

- A. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components. Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

3.08 INSTALLATION OF METAL REVEALS AT WOOD PANELING

- A. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

3.09 INSTALLATION OF CAST-METAL ROSETTES AT MARBLE JOINTS

- A. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a 3/4-inch-round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.
 - 1. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

3.10 CLEANING AND PROTECTION

- A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
- B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
- C. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00 "High-Performance Coatings".
- D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.
- E. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.
- F. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05 73 13

GLAZED DECORATIVE METAL RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glazed decorative metal railings.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood blocking for anchoring railings.

1.02 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor and exterior deck areas and for pedestrian guidance and support, visual separation, or wall protection.

1.03 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.05 ACTION SUBMITTALS

A. Product Data:

1. Metal railings assembled from standard components.
2. Glass products.
3. Glazing cement and accessories for structural glass railings.
4. Sealant and accessories for structural glass railings.
5. Fasteners.
6. Wood rails.
7. Lacquer for copper alloys.
8. Shop primer.
9. Bituminous paint.
10. Nonshrink, nonmetallic grout.

11. Anchoring cement.
- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
 - C. Samples for Initial Selection: For products involving selection of color, texture, or design [, **including mechanical finishes**].
 - D. Samples for Verification: For each type of exposed finish required.
 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 2. Base channel.
 3. Each type of glass and glass edge required.
 4. Fittings and brackets.
 5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, [**structural glass balusters,**] [**and**] [**glass-infill panels**]. Show method of finishing members at intersections. Samples need not be full height.
 - E. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.06 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For [professional engineer] [testing agency].
 - B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
 - C. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
 - D. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
 1. For glazed decorative metal railings.
 2. For post-installed anchors.
 - E. Preconstruction test reports.
- 1.07 QUALITY ASSURANCE
- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockups as indicated on Drawings.
 2. Build mockups for each form and finish of glass-infill panel railing consisting of two posts, top rail, handrail, glass-infill panel, and anchorage system components that are full height and are not less than 24 inches in length.
 3. Build mockups for each form and finish of structural glass railing consisting of top rail, structural glass, base channel, and anchorage system components that are full height and are not less than 24 inches in length.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: **[Owner will engage] [Engage]** a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made **[by Owner] [from the testing and inspecting allowance, as authorized by Change Orders] [by Contractor]**. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.
 1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
 2. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
 3. Notify Architect **[seven] <Insert number>** days in advance of the dates and times when laboratory mockups will be tested.

1.09 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 1. Warranty Period: **[Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 1. Aluminum: The lesser of minimum yield strength divided by 1.65, or minimum ultimate tensile strength divided by 1.95.
 2. Copper Alloys: 60 percent of minimum yield strength.
 3. Stainless Steel: 60 percent of minimum yield strength.

4. Steel: 72 percent of minimum yield strength.
 5. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA CW-12, "Structural Properties of Glass."
- C. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Structural Glass Railings and Glass-Infill Panels:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. For structural glass railings, support each section of top rail **[and handrail]** by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.
 - a. Support top rail **[and handrail]** ends such that railings remains in place if end glass panel fails.
- D. Wind Loads: For exterior glazed decorative metal railings, capable of withstanding the following wind loads in accordance with the IBC and ASTM E1300:
1. Wind Load: **[As indicated on Drawings]** <Insert wind load>.
- E. Windborne-Debris-Impact Resistance: Exterior glazed decorative metal railings passing ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone **[1]** **[2]** **[3]** **[4]** for **[basic]** **[enhanced]** protection.
1. Large-Missile Test: For exterior glazing located within **[30 feet]** <Insert dimension> of grade.
 2. Small-Missile Test: For exterior glazing located between 30 feet and **[60 feet]** <Insert dimension> above grade.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.
- 2.02 GLAZED DECORATIVE METAL RAILINGS
- A. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.
 - B. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.

- C. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

2.03 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.04 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
- B. Extruded Bars and Shapes, Including Extruded Tube: ASTM B221, Alloy 6063-T5/T52.
- C. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.
1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- D. Drawn Seamless Tubing: ASTM B210, Alloy 6063-T832.
- E. Plate and Sheet: ASTM B209, [**Alloy 5005-H32**] [**Alloy 6061-T6**].
- F. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.05 STAINLESS STEEL

- A. Tubing: ASTM A554, [**Grade MT 304**] [**Grade MT 316**].
- B. Pipe: ASTM A312/A312M, [**Grade TP 304**] [**Grade TP 316**].
- C. Castings: ASTM A743/A743M, [Grade CF 8 or Grade CF 20] [Grade CF 8M or Grade CF 3M].
- D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, [**Type 304**] [**Type 316**].
- E. Bars and Shapes: ASTM A276, [**Type 304**] [**Type 316**].

2.06 STEEL AND IRON

- A. Tubing: [ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M].
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

2.07 COPPER ALLOYS

- A. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.
- B. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).
- C. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).
- D. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.
- E. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).
- F. Bronze Seamless Tube: ASTM B135/B135M Alloy UNS C23000 (red brass, 85 percent copper).
- G. Brass Seamless Tube: ASTM B135/B135M Alloy UNS C26000 (cartridge brass, 70 percent copper).
- H. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).
- I. Bronze Castings: [Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)] [or] [sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)].
- J. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).
- K. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.
- L. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).
- M. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).
- N. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).
- O. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.08 GLASS AND GLAZING PRODUCTS, GENERAL

- A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA/GANA Publications: ["**GANALaminated Glazing Reference Manual**" and]"GANA Glazing Manual."
- B. Safety Glazing: Glazing is to comply with 16 CFR 1201, Category II.

- C. Safety Glazing Labeling: Permanently mark glass with certification label of **[the SGCC] [the SGCC or another certification agency acceptable to authorities having jurisdiction] [or] [manufacturer]**. Label is to indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- D. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- E. Low-Iron Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
- F. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- G. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.
- H. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- I. Ceramic-Coated Glass: Heat-strengthened float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.
- J. Bent Glass: ASTM C1464, [Kind BFT (bent, tempered)] [Kind BHS, (bent, heat strengthened)] [Kind BL, (bent, laminated)].
- K. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.
- L. Sealant and Accessories for Structural Glass Railings: Sealant, gaskets, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.
- M. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.09 GLASS HANDRAILS AND GUARDS

- A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.
 - 1. Glass Color: **[Clear] [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>**.
 - 2. Thickness for Structural Glass Balusters: As required by structural loads, but not less than **[12.0] [19.0]** mm.
 - 3. Thickness for Glass-Infill Panels: As required by structural loads, but not less than **[6.0] [10.0]** mm.
 - 4. Glass Thickness: As indicated on Drawings.

- B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.
1. Construction: Laminate glass with [**polyvinyl butyral interlayer**] [or] [**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
 2. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 3. Kind: [**LHS (laminated heat strengthened)**] [**LT (laminated tempered)**] [**As indicated**].
 4. Glass Color: Inner-ply [**clear**] [**low-iron clear**] [**blue**] [**blue-green**] [**bronze**] [**green**] [**gray**] <Insert color>; outer-ply [**clear**] [**low-iron clear**] [**blue**] [**blue-green**] [**bronze**] [**green**] [**gray**] <Insert color>.
 5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**] <Insert manufacturer's color and pattern designation>, applied to [**inner**] [**outer**] glass ply.
 6. Interlayer Color: [**Clear**] [**Blue-green**] [**Bronze light**] [**Gray**] <Insert color>.
 7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**] [**Match**] [**Provide**] <Insert manufacturer's color and pattern designation>.
 8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**] [**8.0**] mm thick each.
 9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**3.0**] [**4.0**] [**5.0**] mm each.
- C. Windborne-Debris-Impact-Resistant Laminated Glass Guards: ASTM C1172, Type II with two plies of glass bonded together with an interlayer.
1. Construction: Laminate glass with [**polyvinyl butyral interlayer**] [or] [**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
 2. Interlayer Thickness: [**0.060 inch**] [**0.090 inch**].
 3. Kind: [**LHS (laminated heat strengthened)**] [**LT (laminated tempered)**] [**As indicated**].
 4. Glass Color: Inner-ply [**clear**] [**low-iron clear**] [**blue**] [**blue-green**] [**bronze**] [**green**] [**gray**] <Insert color>; outer-ply [**clear**] [**low-iron clear**] [**blue**] [**blue-green**] [**bronze**] [**green**] [**gray**] <Insert color>.
 5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**] <Insert manufacturer's color and pattern designation>, applied to [**inner**] [**outer**] glass ply.
 6. Interlayer Color: [**Clear**] [**Blue-green**] [**Bronze light**] [**Gray**] <Insert color>.
 7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**] [**Match**] [**Provide**] <Insert manufacturer's color and pattern designation>.
 8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**] [**8.0**] [**10**] mm thick each.
 9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**4.0**] [**5.0**] mm each.

2.10 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
1. Aluminum Components: [**Type 304**] [**Type 316**] stainless steel fasteners.

2. Stainless Steel Components: **[Type 304] [Type 316]** stainless steel fasteners.
 3. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed; muntz metal (Alloy 280) fasteners where exposed]**.
 4. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed]**.
 5. Dissimilar Metals: **[Type 304] [Type 316]** stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated **[and capable of withstanding design loads]**.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless [otherwise indicated] [exposed fasteners are unavoidable] [exposed fasteners are the standard fastening method for railings indicated].
1. Provide **[Phillips] [tamper-resistant] [square or hex socket]** flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group 1] [Group 2]** stainless steel bolts, ASTM F593, and nuts; ASTM F594.

2.11 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: [Cast aluminum,] [Cast stainless steel,] [Cast bronze,] [Cast brass,] [Cast copper,] [Cast nickel-silver,] center of rail **[2-1/2 inches] [3-1/8 inches]** <Insert dimension> from face of structural glass balusters.
- B. Wood Rails:
1. Clear, straight-grained hardwood rails secured to **[recessed] [exposed]** metal subrail.
 - a. Species: **[Ash] [Cherry] [Red oak] [Walnut] [White oak]** <Insert species>.
 - b. Finish: **[Manufacturer's standard] [Transparent polyurethane] [Penetrating oil] [Acrylic impregnated]**.
 - c. Staining: **[None] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert description or manufacturer's name and product designation>.
 - d. Profile: **[Square, 1-3/4 by 1-3/4 inches with edges eased to 1/4-inch radius] [Rectangular, 1-3/4 by 5 inches with edges eased to 1/4-inch radius] [Round, 2-inch diameter] [As indicated]** <Insert description>.
 2. Hardwood rails complying with Section 06 40 23 "Interior Architectural Woodwork."
- C. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.

- D. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MP#79.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Anchoring Cement: **[At exterior locations] [and] [where indicated]** provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.12 FABRICATION OF METAL RAILINGS

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage [, **but not less than that required to support structural loads**].
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- H. Form changes in direction as follows:
 - 1. As detailed.
 - 2. **[By bending] [or] [by inserting prefabricated elbow fittings]**.
 - 3. **[By flush bends] [or] [by inserting prefabricated flush-elbow fittings]**.
 - 4. **[By radius bends of radius indicated] [or] [by inserting prefabricated elbow fittings of radius indicated]**.

5. By bending to smallest radius that will not result in distortion of railing member.
 - I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
 - J. Close exposed ends of hollow railing members with prefabricated end fittings.
 - K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.
 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.
 - L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
 - M. For railing posts set in concrete, provide **[steel] [stainless steel]** sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- 2.13 FABRICATION OF GLASS PANELS AND BALUSTERS
- A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
 - B. Glass-Infill Panels: Provide [tempered] [laminated, heat-strengthened] [laminated, tempered] glass-infill panels [for both straight and curved sections].
 1. Edge Finish: **[Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces] <Insert edge finishes>**.
 - C. Structural Glass Balusters: Provide [tempered] [laminated, heat-strengthened] [laminated, tempered] structural glass balusters [for both straight and curved sections].
 1. Edge Finish: **[Grind smooth and flat polish exposed edges of glass, including those at open joints, to produce smooth, square edges with glass edge finishes]**.
 2. Factory-bond structural glass balusters to aluminum base and top-rail channels in railing manufacturer's plant using **[glazing cement] [sealant]** to comply with manufacturer's written instructions [, **unless field glazing is standard with manufacturer]**.
 3. Fabricate structural glass balusters to maintain equal length glass widths and uniform spacing of **[1/2 inch] <Insert spacing>** between glass balusters.
- 2.14 METAL FINISH REQUIREMENTS, GENERAL
- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.15 ALUMINUM FINISHES

- A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
- B. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- C. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
 - 1. Color: **[Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>**.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 - 1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - 1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

- G. Superior-Performing Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.
- H. Superior-Performing Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.
- I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.
- J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.
- 2.16 STAINLESS STEEL FINISHES
- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1. Run grain of directional finishes with long dimension of each piece.
 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Tubing Finishes:
1. 180-Grit Polished Finish: Uniform, directionally textured finish.
 2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**] [**to a mirrorlike finish**] [**to match Architect's sample**].
- D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.17 COPPER-ALLOY FINISHES

- A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM/NOMMA 500, "Metal Finishes Manual for Architectural and Metal Products."
- B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
- C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
- D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
- E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
- F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).
 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).
 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).
 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).
 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
 1. Color: Match Architect's sample.

- K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate) [, **with color matching Architect's sample**].

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.
- B. Windborne-Debris Resistance: Anchor glazed decorative metal railings to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris-resistance testing.
- C. Perform cutting, drilling, and fitting required for installing metal railings.
1. Fit exposed connections together to form tight, hairline joints.
 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of metal railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat concealed surfaces of [**aluminum**] [**and**] [**copper alloys**] that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with [**shop primer**] [**bituminous paint**].
- E. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.02 METAL RAILING CONNECTIONS

- A. Nonwelded Connections:
1. Use mechanical or adhesive joints for permanently connecting railing components.
 2. Use wood blocks and padding to prevent damage to railing members and fittings.
 3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

- B. Expansion Joints: Install expansion joints at locations indicated, but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.03 METAL ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted in sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, [welded to post after placing anchoring material] [attached to post with setscrews].
- D. Leave anchorage joint exposed with [**1/8-inch** buildup, sloped away from post] [anchoring material flush with adjacent surface].
- E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
 - 3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
- F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.04 INSTALLATION OF GLASS BALUSTERS

- A. Structural Glass Railings:
 - 1. Install assembly to comply with railing manufacturer's written instructions.
 - 2. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass balusters [**if glass was bonded to base and top-rail channels in factory**].
 - 3. For field-assembled balusters, attach base channel to building structure, insert glass in base channel, and bond with [**glazing cement**] [**sealant**].
 - a. Support glass balusters in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.
 - b. Fill remaining space in base channel with [**glazing cement**] [**sealant**] for uniform support of glass.
 - 4. Adjust spacing of glass balusters so gaps between balusters are equal before securing in position.

5. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

B. Post-Supported Railings with Glass-Infill Panels:

1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made **[by Owner] [from the testing and inspecting allowance, as authorized by Change Orders]**.
- B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.
- C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.
- D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.06 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.
- B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
- C. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- D. Clean wood rails by wiping with a damp cloth and then wiping dry.

3.07 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

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DIVISION 06
WOOD AND COMPOSITES

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SECTION 06 10 53

MISCELLANEOUS CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Wood nailers and blockings.
 - 2. Rough hardware.
 - 3. Plywood backboards for electrical and telephone equipment.
- B. Related requirements: Painting plywood backboards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
 - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Material Certificates:
 - 1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
 - 2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.3 QUALITY ASSURANCE

- A. Fire-retardant wood products shall be manufactured under the independent third party inspection of UL
- B. Follow-Up Service and each piece shall bear the UL classified mark indicating the extended ASTM E 84 test
- C. Each piece shall be labeled kiln dried after treatment (KDAT).

1.4 HANDLING

- A. Procedure: In accordance with AWWPA recommendations for storage and protection of pressure-treated wood.
- B. Do not store materials in wet or damp areas.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Nailers and blockings:
 - 1. No. 1 or No. 2 grade Douglas fir, S4S, seasoned to moisture content of 19 percent maximum and stamped S-Dry, graded in compliance with WCLIB Grading Rules.
 - 2. If specifications for pressure treatment state the maximum percentages of moisture content at the time of treatment, comply with those requirements in lieu of the above.
- B. Plywood:
 - 1. Telephone and electrical equipment backing panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, thickness indicated or, if not indicated, not less than 1/2 inch thick.
 - 2. Elsewhere: Softwood plywood APA, Exterior Grade, C-C Plugged.
- C. Rough hardware:
 - 1. General: Use hot-dip galvanized (not electro-plated) Type 316 stainless steel fasteners complying with G185 to attach pressure-treated wood.
 - 2. For fastening lumber-to-lumber: Cement-coated or annular threaded nails of sufficient length to penetrate a minimum of 1-1/4-inch into adjoining members, or stove or lag bolts used with washers.
 - 3. For fastening plywood-to-lumber: Ring shank or annular threaded nails; 8d for 1/2-inch plywood and 10d for 3/4-inch plywood.
 - 4. For fastening plywood or lumber to steel: Minimum #10 galvanized full threaded screws driven thru 5/8-inch diameter steel washers.
 - 5. For fastening plywood or lumber to concrete or masonry: Corrosion-resistant drilled expansion type anchors or power-driven anchors by Hilti Fastening Systems, Molly Division of USM Corp., Redhead, or equal, capable of resisting a withdrawal force of 400 lb. each without failure.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWWPA U1, Use categories as follows:
 - 1. UC1: Interior construction not in contact with ground or subject to moisture. Include [all rough carpentry.] [the following items:]
 - 1) Wood sills, sleepers, blocking, [furring,] [stripping,] and similar concealed members in contact with masonry or concrete.
 - 2) Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - 3) Wood floor plates that are installed over concrete slabs-on-grade.
 - 4) Wood furniture.
 - 5) Wood millwork.
 - 6) <Insert item>.

2. UC2: Interior construction not in contact with ground but may be subject to moisture. Include [all rough carpentry.] [the following items:]
 - a. Wood sills, sleepers, blocking, [furring,] [stripping,] and similar concealed members in contact with masonry or concrete.
 - b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - c. Wood floor plates that are installed over concrete slabs-on-grade.
 - d. Wood millwork.
 - e. Wood flooring.
 - f. <Insert item>.
3. UC3A (Commodity Specification A): Coated sawn products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include [all rough carpentry.] [the following items:]
 - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - c. Wood siding and trim.
 - d. <Insert item>.
4. UC3A (All Other Commodity Specifications): Coated products excluding sawn products in exterior construction not in contact with ground, exposed to all weather cycles but protected from liquid water. Include [all rough carpentry.] [the following items:]
 - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - c. Wood floor plates that are installed over concrete slabs-on-grade.
 - d. Wood siding and trim.
 - e. Wood sheathing.
 - f. <Insert item>.
5. UC3B (Commodity Specification A): Uncoated sawn products in exterior construction not in contact with ground, exposed to all weather cycles including intermittent wetting but with sufficient air circulation for wood to dry. Excludes sawn products not in contact with ground but with ground contact-type hazards. Include [all rough carpentry.] [the following items:]
 - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - c. Wood decking, railings, and joists and beams for decks that are not critical to the performance and safety of the entire system/construction and that are in locations easily accessible for maintenance, repair, or replacement.

- d. <Insert item>.
6. UC3B (All Other Commodity Specifications): Uncoated products excluding sawn products in exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting. Include [all rough carpentry.] [the following items:]
- a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - c. <Insert item>.
7. UC4A (Commodity Specification A): Non-critical sawn products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, and sawn products not in contact with ground but with ground contact-type hazards or that are critical or hard to replace. Include [all rough carpentry.] [the following items:]
- a. Wood framing members that are less than 6 inches (152 mm) above the ground.
 - b. Joists and beams when they are difficult to maintain, repair, or replace and are critical to the performance and safety of the entire system/construction.
 - c. <Insert item>.
8. UC4A (All Other Commodity Specifications): Non-critical products excluding sawn products in contact with ground and exposed to all weather cycles, normal exposure conditions. Include [all rough carpentry.] [the following items:]
- a. <Insert item>.
9. UC4B (Commodity Specification A): Critical or difficult-to-replace sawn products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, high decay potential, and salt water splash. Include [all rough carpentry.] [the following items:]
- a. Wood foundations.
 - b. <Insert item>.
10. UC4B (All Other Commodity Specifications): Critical or difficult-to-replace products excluding sawn products in contact with ground and exposed to all weather cycles including high decay potential and salt water splash. Include [all rough carpentry.] [the following items:]
- a. <Insert item>.
11. UC4C (Commodity Specification A): Critical structural sawn products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, severe environments, and extreme decay potential. Include [all rough carpentry.] [the following items:]
- a. Wood foundation piling.
 - b. <Insert item>.
12. UC4C (All Other Commodity Specifications): Critical structural products excluding sawn products in contact with ground and exposed to all weather cycles including severe environments and extreme decay potential. Include [all rough carpentry.] [the following items:]
- a. Wood foundation piling.
 - b. <Insert item>.

13. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. [Do not use inorganic boron (SBX) for sill plates.]
 14. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
 15. After treatment, redry [boards] [dimension lumber] to 19 percent maximum moisture content.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, [mark end or back of each piece] [or] [omit marking and provide certificates of treatment compliance issued by inspection agency].
- D. Application: Treat [all rough carpentry unless otherwise indicated.] [items indicated on Drawings, and the following:]
1. Retain first subparagraph below if Project includes wood adjacent to roofing or waterproofing.
 2. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 3. Wood sills, sleepers, blocking, [furring,] [stripping,] and similar concealed members in contact with masonry or concrete.
 4. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 5. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 6. Wood floor plates that are installed over concrete slabs-on-grade.
 7. <Insert item>.

2.3 FIRE-RETARDANT TREATED WOOD

- A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Treatment is not to promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 4. Design Value Adjustment Factors: Treated lumber is to be tested according to ASTM D5664 and design value adjustment factors are to be calculated according to ASTM D6841. [For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.]
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. [Kiln-dry plywood after treatment to maximum moisture content of 15 percent.]
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.
1. For exposed lumber indicated to receive a stained or natural finish, [mark end or back of each piece] [or] [omit marking and provide certificates of treatment compliance issued by testing agency].
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat [all rough carpentry unless otherwise indicated.] [items indicated on Drawings, and the following:]
1. Concealed blocking.
 2. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 3. Plywood backing panels.
 4. <Insert item>.
- G. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements in AWWA C20 (lumber) and AWWA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, US Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to AHJ.
- H. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to ASTM D 5664 for lumber and ASTM D 5516 for plywood.
- I. Use treatment free of halogens, sulfates, chlorides, arsenic, ammonium phosphate, formaldehyde, urea formaldehyde, and that does not promote corrosion of metal fasteners.
1. Exterior: Fire-retardant treatment is free of halogens, sulfates, chlorides, ammonium phosphate, and contains no added urea formaldehyde
 - a. "Exterior-Fire-X" by Hoover Treated Wood Products (basis of design), FRX FRT Wood by Arch Wood Protection, or equal.
 - b. Shall be kiln-dried to a maximum moisture content of 19% for lumber and 15% for plywood.
 - c. Plywood shall have a minimum bond durability of Exposure 1 in accordance with US Product Standard PS 1, Construction and Industrial Plywood.
 - d. Grade marked structural lumber treated with EXTERIOR FIRE-X® shall be in accordance with PS 20.

2. Interior: "Type A" fire-retardant with individual surface burning characteristics for the species and products listed under UL Certifications.
 - a. "Pyro-Guard" by Hoover Treated Wood Products, Dricon FRT by Arch Wood Protection, or equal.
 - b. Plywood treated with PYRO-GUARD® shall be manufactured under US Product Standards - PS 1 or PS 2. Panels shall have a minimum bond durability of Exposure 1.
 - c. Grade marked lumber treated with PYRO-GUARD® shall be in accordance with PS 20

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.

3.2 PREPARATION

- A. Paint backboard panels before installation as specified in Section 09 90 00.

3.3 INSTALLATION

- A. Subdrill holes in pieces where splitting may occur; size holes slightly smaller than diameter of nail.
- B. Do not drive nails closer to edge of lumber than 1/4 length.
- C. Remove lumber split in nailing and replace with sound members.
- D. Make joints accurately and neatly, square, flush and tight.
- E. Install wood screws and lag bolts with complete penetration to head. Bore lead holes equal to root diameter of the screw or bolt. Drive flush or recess with nailer face.
- F. Pressure-treated wood products: Do not rip or mill treated lumber. End cuts, drilling holes and joining cuts are permitted. Plywood may be cut in any direction.
 1. Fire-retardant-treated wood used in structural applications shall be installed in accordance with the conditions and limitations listed in UL ER7002-01.
 2. Use pressure-treated wood where required by Code and as specified above.
 3. Use fire-treated wood where required for blockings and nailers located in metal-framed walls, partitions and ceilings.
 4. Field apply sealing coating to end cut wood members and ripped plywood with a coating that is compatible with the pressure treated wood product and has similar protection properties.
- G. Provide nailers and blockings where indicated and required.
 1. Template and drill to match anchor bolts in steel members, concrete and masonry.

2. Where materials are applied over flush nailer surfaces, use carriage bolts with heads drawn flush into top of nailer or blockings, or counterbore holes to recess washers and heads of nuts.

3.4 ANCHORAGE

A. Fastening lumber or plywood to lumber:

1. Space nails a maximum of 12 inches o.c. and stagger across face of piece. Locate fastener also within 3 inches of each end of piece.
2. Drive nail heads flush with wood surfaces. Nails shall penetrate adjoining piece a minimum of 1-1/4-inch.

B. Fastening lumber or plywood to concrete or to masonry:

1. Space anchors a maximum of 36 inches o.c. and stagger if lumber is more than 5 inches wide.
2. Make anchor heads flat or countersunk flush with surface, but not countersunk more than 1/3 the thickness of piece to be fastened.
3. Anchor withdrawal resistance shall be a minimum of 400 lb. per anchor, or number of fasteners increased accordingly from that specified. Minimum penetration of 1-1/2-inch into concrete or masonry.

C. Fastening lumber or plywood to steel:

1. Space screws a maximum of 24 inches o.c. and stagger if lumber is more than 5 inches wide.
2. Drive screw heads flush with face of plywood or lumber.
3. Anchor shall penetrate a minimum of 1/4 inch through the steel.

3.5 CLEANUP

- A. Comply with the requirements of Division One.
- B. Do not bury wood of any type on the jobsite.

END OF SECTION

SECTION 06 16 00

SHEATHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring and underlayment.
6. Sheathing joint-and-penetration treatment materials.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for plywood backing panels.
2. Section 07 25 00 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring and underlayment.
6. Sheathing joint-and-penetration treatment materials.

B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
 4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.
- C. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
 2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 3. Include details of interfaces with other materials that form part of air barrier.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer [, including list of ABAA-certified installers and supervisors employed by Installer, who work on Project] [and] [testing and inspecting agency].
- B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.
- C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated plywood.
 2. Fire-retardant-treated plywood.
 3. Foam-plastic sheathing.
 4. Air-barrier and water-resistant glass-mat gypsum sheathing.
- E. Field quality-control reports.
- 1.05 QUALITY ASSURANCE
- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.
1. Installer is to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and is to employ ABAA-certified installers and supervisors on Project.

- B. Mockups: Build mockups to set quality standards for materials and execution [**and for preconstruction testing**].
1. Build integrated mockups of exterior wall assembly [**as indicated on Drawings**] [, **150 sq. ft.**] <Insert requirement>, incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
 - b. Include junction with roofing membrane [, **building corner condition,**] [**and foundation wall intersection**].
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Testing Agency Qualifications:
1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
 2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified in accordance with ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: [**Owner will engage**] [**Engage**] a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies are to comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**] [**ASTM E1186, chamber depressurization with detection liquids**] <Insert requirement>.
 2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [**ASTM E783**] [or] [**ASTM E2357**].
 3. Notify Architect [**seven**] <Insert number> days in advance of the dates and times when mockups will be tested.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [, **tie-ins to installed waterproofing**] [, **tie-ins to other installed air barriers**], and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.02 WOOD PANEL PRODUCTS

- A. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.03 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2[for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground].
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: [Treat all plywood unless otherwise indicated] [Treat items indicated on Drawings] [and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing].

2.04 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber plywood is to be tested in accordance with ASTM D5516 and design value adjustment factors are to be calculated in accordance with ASTM D6305. Span ratings after treatment are to be not less than span ratings specified. [**For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F are to be not less than span ratings specified.**]
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: [Treat all plywood unless otherwise indicated.] [Treat plywood indicated on Drawings, and the following:]
 - 1. Roof [**and wall**] sheathing within 48 inches of [**fire**] [**party**] walls.
 - 2. Roof sheathing.
 - 3. Subflooring and underlayment for raised platforms.
 - 4. **<Insert category of plywood items required to be treated>**.

2.05 WALL SHEATHING

- A. Plywood Sheathing, Walls: [DOC PS 1] [Either DOC PS 1 or DOC PS 2], [Exterior, Structural I] [Exterior] [Exposure 1, Structural I] [Exposure 1] sheathing.
 - 1. Span Rating: Not less than [**16/0**] [**20/0**] [**24/0**] [**32/16**].
 - 2. Nominal Thickness: Not less than [**1 1/32 inch**] [**3/8 inch**] [**1/2 inch**].
- B. Oriented-Strand-Board Sheathing, Walls: DOC PS 2, [**Exposure 1, Structural I**] [**Exposure 1**] sheathing.
 - 1. Span Rating: Not less than [**16/0**] [**20/0**] [**24/0**] [**24/16**] [**32/16**].

2. Nominal Thickness: Not less than **[5/16 inch] [3/8 inch] [1/2 inch]**.
- C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
1. Type and Thickness: **[Regular, 1/2 inch] [Type X, 5/8 inch]** thick.
 2. Edge and End Configuration: **[V-shaped, tongue-and-groove long edges; square ends] [Square]**.
 3. Size: **[24 by 96 inches for horizontal] [48 by 96 inches for vertical] [48 by 108 inches for vertical] [600 by 2400 mm for horizontal] [1200 by 2400 mm for vertical] [1200 by 2750 mm for vertical]** installation.
- D. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.
1. Type and Thickness: **[Regular, 1/2 inch] [Type X, 5/8 inch]** thick.
 2. Size: **[48 by 96 inches] [48 by 108 inches] [48 by 120 inches] [1200 by 2400 mm] [1200 by 2750 mm] [1200 by 3050 mm]** for vertical installation.
- E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.
1. Thickness: 5/8 inch thick.
 2. Size: **[48 by 96 inches] [48 by 108 inches] [48 by 120 inches] [1200 by 2400 mm] [1200 by 2750 mm] [1200 by 3050 mm]** for vertical installation.
 3. Edges: Square.
 4. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
 5. Air Permeance: Maximum **[0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft.] <Insert value>** pressure difference when tested in accordance with ASTM E2178.
 6. Vapor Permeance: Minimum **[20 perms] <Insert value>** when tested in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.
 7. Sheathing Assembly Air Leakage: Maximum **[0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.] <Insert value>** when tested in accordance with ASTM E2357.
 8. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
 9. UV Resistance: Can be exposed to sunlight for **[30] [90] [180] <Insert number>** days in accordance with manufacturer's written instructions.
 10. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- F. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing.

1. Type and Thickness: **[Regular, 1/2 inch]** **[Type X, 5/8 inch]** thick.
2. Size: **[48 by 96 inches]** **[48 by 108 inches]** **[48 by 120 inches]** **[1200 by 2400 mm]** **[1200 by 2750 mm]** **[1200 by 3050 mm]**.

G. Cementitious Backer Units, Walls: ASTM C1325, Type A.

1. Thickness: **[1/2 inch]** **[5/8 inch]** **[As indicated]**.

H. Fiberboard Sheathing: ASTM C208, Type IV, **[Grade 1 (Regular)]** **[Grade 2 (Structural)]** cellulosic fiberboard sheathing with square edges, **[1/2 inch]** **[25/32 inch]** thick.

I. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.

1. Thickness: **[3/4 inch]** **[1 inch]** **[As indicated]**.
2. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

J. Foil-Faced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings are to have a flame-spread index of 25 or less when tested individually.

1. Thickness: **[7/16 inch]** **[1/2 inch]** **[5/8 inch]** **[3/4 inch]** **[1 inch]** **[As indicated]**.
2. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

2.06 ROOF SHEATHING

A. Plywood Sheathing, Roofs: **[DOC PS 1]** **[Either DOC PS 1 or DOC PS 2]**, **[Exterior, Structural I]** **[Exterior]** **[Exposure 1, Structural I]** **[Exposure 1]** sheathing.

1. Span Rating: Not less than **[16/0]** **[20/0]** **[24/0]** **[32/16]** **[40/20]** **[48/24]**.
2. Nominal Thickness: Not less than **[15/32 inch]** **[1/2 inch]**.

B. Oriented-Strand-Board Sheathing, Roofs: DOC PS 2, **[Exposure 1, Structural I]** **[Exposure 1]** sheathing.

1. Span Rating: Not less than **[16/0]** **[20/0]** **[24/0]** **[24/16]** **[32/16]** **[40/20]** **[48/24]**.
2. Nominal Thickness: Not less than **[7/16 inch]** **[15/32 inch]** **[1/2 inch]** **[5/8 inch]** **[3/4 inch]**.

2.07 PARAPET SHEATHING

A. Plywood Sheathing, Parapets: **[DOC PS 1]** **[Either DOC PS 1 or DOC PS 2]**, **[Exterior, Structural I]** **[Exterior]** **[Exposure 1, Structural I]** **[Exposure 1]** sheathing.

1. Span Rating: Not less than **[16/0]** **[20/0]** **[24/0]** **[32/16]** **[40/20]** **[48/24]**.
2. Nominal Thickness: Not less than **[15/32 inch]** **[1/2 inch]**.

B. Oriented-Strand-Board Sheathing, Parapets: DOC PS 2, **[Exposure 1, Structural I]** **[Exposure 1]** sheathing.

1. Span Rating: Not less than [16/0] [20/0] [24/0] [24/16] [32/16] [40/20] [48/24].
2. Nominal Thickness: Not less than [7/16 inch] [15/32 inch] [1/2 inch] [5/8 inch] [3/4 inch].

C. Glass-Mat Gypsum Sheathing, Parapets: ASTM C1177/C1177M.

1. Type and Thickness: [Regular, 1/2 inch] [Type X, 5/8 inch] thick.
2. Size: [48 by 96 inches] [48 by 108 inches] [48 by 120 inches] [1200 by 2400 mm] [1200 by 2750 mm] [1200 by 3050 mm] for vertical installation.

D. Cementitious Backer Units, Parapets: ASTM C1325, Type A.

1. Thickness: [1/2 inch] [5/8 inch] [As indicated].

2.08 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.

1. Polyisocyanurate-Foam Thickness: [1 inch] [1-1/2 inches] [2 inches] [2-1/2 inches] [3 inches] [3-1/2 inches] [4 inches].
2. Oriented-Strand-Board Nominal Thickness: [7/16 inch] [5/8 inch].

B. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type II, Class 1, with DOC PS 2, Exposure 1 oriented strand board adhered to spacers on one face.

1. Polyisocyanurate-Foam Thickness: [1 inch] [1-1/2 inches] [2 inches] [2-1/2 inches] [3 inches] [3-1/2 inches] [4 inches].
2. Oriented-Strand-Board Nominal Thickness: [7/16 inch] [5/8 inch].
3. Spacers: Wood furring strips or blocks not less than 3/4 inch thick and spaced not more than [12 inches] [16 inches] [24 inches] o.c.

2.09 SUBFLOORING AND UNDERLAYMENT

A. Plywood Combination Subfloor-Underlayment: DOC PS 1, [Exterior, Structural I, C-C Plugged] [Exterior, C-C Plugged] [Exposure 1, Structural I, Underlayment] [Exposure 1, Underlayment] single-floor panels.

1. Span Rating: Not less than [16] [20] [24] [32] [48].
2. Nominal Thickness: Not less than [23/32 inch] [7/8 inch] [1 inch].
3. Edge Detail: [Square] [Tongue and groove].
4. Surface Finish: Fully sanded face.

B. Oriented-Strand-Board Combination Subfloor-Underlayment: DOC PS 2, Exposure 1 single-floor panels.

1. Span Rating: Not less than [16] [20] [24] [32] [48].
2. Nominal Thickness: Not less than [23/32 inch] [7/8 inch] [1 inch].

3. Edge Detail: [**Square**] [**Tongue and groove**].
 4. Surface Finish: [**Fully sanded**] [**Resin-impregnated overlay**] face.
- C. Plywood Subflooring: [DOC PS 1] [Either DOC PS 1 or DOC PS 2], [Exterior, Structural I] [Exterior] [Exposure 1, Structural I] [Exposure 1] single-floor panels or sheathing.
1. Span Rating: Not less than [**16**] [**20**] [**24**] [**32**] [**48**] [or] [**32/16**] [**40/20**] [**48/24**].
 2. Nominal Thickness: Not less than [**23/32 inch**] [**7/8 inch**] [**1 inch**].
- D. Oriented-Strand-Board Subflooring: DOC PS 2, Exposure 1[, **Structural I sheathing**] [**single-floor panels or sheathing**].
1. Span Rating: Not less than [**16**] [**20**] [**24**] [**32**] [**48**] [or] [**32/16**] [**40/20**] [**48/24**] [**60/32**].
 2. Nominal Thickness: Not less than [**23/32 inch**] [**7/8 inch**] [**1 inch**].
- E. Underlayment: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch over smooth subfloors and not less than 3/8 inch over board or uneven subfloors.
1. Plywood Underlayment for Resilient Flooring: DOC PS 1, [**Exterior A-C**] [**Exterior B-C**] [**Exterior, C-C Plugged**] [**Exposure 1 Underlayment**] with fully sanded face.
 2. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch nominal thickness.
 3. Plywood Underlayment for Carpet: DOC PS 1, [**Exterior, C-C Plugged**] [**Exposure 1, Underlayment**] [**Interior, Underlayment**].
 4. Particleboard Underlayment: ANSI A208.1, [**Grade PBU**] [**Grade M-2**].
 5. Hardboard Underlayment: ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.10 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For [**roof**] [**parapet**] [**and**] [**wall**] sheathing, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**] [**of Type 304 stainless steel**].
 2. For [**roof**] [**parapet**] [**and**] [**wall**] sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
 - 1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.
- G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.11 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Paper-Surfaced and Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 07 92 00 "Joint Sealants."
- B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.
- C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.12 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with **[APA AFG-01]** **[ASTM D3498]** that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.

2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 3. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate **[wall]** **[parapet]** **[and]** **[roof]** sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.02 INSTALLATION OF WOOD STRUCTURAL PANEL

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
1. Combination Subfloor-Underlayment:
 - a. **[Glue and nail]** **[Nail]** to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 2. Subflooring:
 - a. **[Glue and nail]** **[Nail]** **[Nail or staple]** to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 3. Wall and Roof Sheathing:
 - a. **[Nail]** **[Nail or staple]** to wood framing. **[Apply a continuous bead of glue to framing members at edges of wall sheathing panels.]**
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 4. Underlayment:
 - a. **[Nail]** **[Nail or staple]** to subflooring.
 - b. Space panels 1/32 inch apart at edges and ends.
 - c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.03 INSTALLATION OF GYPSUM SHEATHING

- A. Comply with GA-253 and with manufacturer's written instructions.
1. Fasten gypsum sheathing to wood framing with **[nails] [or] [screws]**.
 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
- F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:
1. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.
 - a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches of coverage is achieved over each substrate.

2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [**transition strip**] [**preformed silicone extrusion**], so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
 - a. Transition Strip: Roll firmly to enhance adhesion.
 - b. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
7. Seal top of through-wall flashings to sheathing with an additional 6-inch-wide, transition strip.
8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches beyond repaired areas in strip direction.

3.04 INSTALLATION OF CEMENTITIOUS BACKER UNITS

- A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.05 INSTALLATION OF FIBERBOARD SHEATHING

- A. Comply with ASTM C846 and with manufacturer's written instructions.
- B. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails[**or galvanized staples**]; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least 3/8 inch from edges and ends.
- C. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow 1/8-inch open space between edges and ends of adjacent units. Stagger horizontal joints if any.
- D. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

3.06 INSTALLATION OF FOAM-PLASTIC SHEATHING

- A. Comply with manufacturer's written instructions.

- B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.
- C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

3.07 INSTALLATION OF PARTICLEBOARD UNDERLAYMENT

- A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.
 - 1. Fastening Method: **[Glue and nail]** **[Nail]** **[Nail or staple]** underlayment to subflooring.

3.08 INSTALLATION OF HARDBOARD UNDERLAYMENT

- A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.
 - 1. Fastening Method: **[Nail]** **[Nail or staple]** underlayment to subflooring.

3.09 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing and Inspecting Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. **[Inspections may include the following:]**
 - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 3. Termination mastic has been applied on cut edges.
 - 4. Strips and transition strips have been firmly adhered to substrate.
 - 5. Compatible materials have been used.
 - 6. Transitions at changes in direction and structural support at gaps have been provided.
 - 7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 - 8. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
 - 1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage in accordance with **[ASTM E1186, chamber pressurization or depressurization with smoke tracers]** **[ASTM E1186, chamber depressurization using detection liquids]** **<Insert requirement>**.

2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [**ASTM E783**] [or] [**ASTM E2357**].
 - E. Air barriers will be considered defective if they do not pass tests and inspections.
 - F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
 - G. Prepare test and inspection reports.

END OF SECTION

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SECTION 06 16 63
CEMENTITIOUS SHEATHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Subflooring and underlayment.
5. Sheathing joint-and-penetration treatment materials.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for plywood backing panels.
2. Section 07 25 00 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Subflooring and underlayment.
5. Sheathing joint-and-penetration treatment materials.

B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated plywood.
- C. Field quality-control reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 WALL SHEATHING

- A. Cementitious Backer Units, Walls: ASTM C1325, Type A.
 - 1. Thickness: [1/2 inch] [5/8 inch] [As indicated].

2.02 PARAPET SHEATHING

- A. Cementitious Backer Units, Parapets: ASTM C1325, Type A.
 - 1. Thickness: [1/2 inch] [5/8 inch] [As indicated].

2.03 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For [roof] [parapet] [and] [wall] sheathing, provide fasteners [with hot-dip zinc coating complying with ASTM A153/A153M] [of Type 304 stainless steel].
 - 2. For [roof] [parapet] [and] [wall] sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
 - 1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.
- G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.10.1, "Fastening Schedule," in the California Building Code (CBC).
 - 2. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate [wall] [parapet] [and] [roof] sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.02 INSTALLATION OF CEMENTITIOUS BACKER UNITS

- A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.
- B. Precut panels and make accurate cutouts for penetrations.
- C. Install boards with a 3/8-inch gap where non-load-bearing construction they abut structural elements.
- D. To prevent wicking, install boards with a 1/4-inch gap where they abut materials that might retain moisture.
- E. Attach board at 8 inches o.c.; set fasteners back 3/8-inch minimum from edges. Drive fasteners so heads bear tightly against face of boards but do not cut into facing.
- F. Pre-fill gap between boards with bonding material then embed 2-inch mesh tape and smooth material over joint and corner.

END OF SECTION

SECTION 06 20 23
INTERIOR FINISH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior trim.
2. Paneling.
3. Shelving and clothes rods.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view [and for framing exposed to view].
2. Section 06 40 23 "Interior Architectural Woodwork" for shop-fabricated carpentry.
3. Section 09 91 23 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.02 DEFINITIONS

- A. MDF: Medium-density fiberboard.
- B. MDO: Plywood with a medium-density overlay on the face.
- C. PVC: Polyvinyl chloride.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Interior trim.
2. Paneling.
3. Shelving and clothes rods.

B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.

C. Samples: For each exposed product and for each color and texture specified.

- D. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
- E. Samples for Verification:
 - 1. For each species and cut of lumber and panel products with nonfactory-applied finish, with half of exposed surface finished; 50 sq. in. for lumber and 8 by 10 inches for panels.
 - 2. For foam-plastic moldings, with half of exposed surface finished; 50 sq. in..
 - 3. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. for lumber and 8 by 10 inches for panels.

1.04 QUALITY ASSURANCE

A.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 - 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 - 2. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements; see current Campus Standards for Preferred Manufacturers.

2.02 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece [, or omit grade stamp and provide certificates of grade compliance issued by grading agency].
- B. Softwood Plywood: DOC PS 1.
- C. Hardboard: ANSI A135.4.
- D. MDF: ANSI A208.2, [Grade 130] <Insert grade>.
- E. Particleboard: ANSI A208.1, [Grade M-2] [Grade M-2-Exterior Glue].
- F. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with ISO 4586-3, Grade VGS.
 - 1. Color: [White] [Black] [Gray] [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>.

2.03 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category [UC1] [UC2].
 - 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent, respectively.
 - 2. Preservative Chemicals: Acceptable to authorities having jurisdiction [and containing no arsenic or chromium].
 - 3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
 - 4. Do not use material that is warped or does not comply with requirements for untreated material.
 - 5. Mark lumber with treatment-quality mark of an inspection agency approved by the ALSC's Board of Review.
 - a. For exposed lumber indicated to receive a stained or natural finish, [mark end or back of each piece] [or] [omit marking and provide certificates of treatment compliance issued by inspection agency].
 - 6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
 - a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
 - 7. Application: [Where indicated on Drawings] [All interior lumber and plywood] <Insert application>.

INTERIOR TRIM

B. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade:
 - a. Eastern white pine; NeLMA or NLGA [C Select] [D Select] [Finish or 1 Common] [Premium or 2 Common].
 - b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [C Select (Choice)] [D Select (Quality)] [1 Common (Colonial)] [2 Common (Sterling)].
 - c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [C Select (Choice)] [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)].
 - d. White woods; WWPA [C Select] [D Select] [1 Common] [2 Common].
 - e. Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA [Superior or C & Btr] [Prime or D] finish.
 - f. Southern pine; SPIB [B & B] [C & Btr] finish.
 - g. Western red cedar; NLGA, WCLIB, or WWPA [Clear Heart] [Grade A] [Grade B].
2. Maximum Moisture Content: [19] [15] percent [with at least 85 percent of shipment at 12 percent or less].
3. Finger Jointing: [Allowed] [Not allowed].
4. Face Surface: [Surfaced (smooth)] [Saw textured].

C. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade: [Red oak] [White maple] [Alder] [Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar] <Insert species>; NHLA [Clear] [A Finish] [B Finish].
2. Maximum Moisture Content: [13] [10] [9] <Insert number> percent.
3. Finger Jointing: Not allowed.
4. Gluing for Width: [Allowed] [Not allowed] [Use for lumber trim wider than 6 inches].
5. Veneered Material: [Allowed] [Not allowed] [Use for lumber trim wider than 6 inches].
6. Face Surface: [Surfaced (smooth)] [Saw textured].
7. Matching: Selected for compatible grain and color.

D. Lumber Trim for Opaque Finish (Painted Finish):

1. Species and Grade:
 - a. Eastern white pine; NeLMA or NLGA [D Select] [Finish or 1 Common] [Premium or 2 Common].
 - b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [D Select (Quality)] [1 Common (Colonial)] [2 Common (Sterling)].
 - c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)].
 - d. White woods; WWPA [D Select] [1 Common] [2 Common].

- e. Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA [Superior or C & Btr] [Prime or D] finish.
 - f. Spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA [1 Common] [2 Common].
 - g. Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; NHLA [A Finish] [B Finish].
2. Maximum Moisture Content for Softwoods: [19] [15] percent [with at least 85 percent of shipment at 12 percent or less].
 3. Maximum Moisture Content for Hardwoods: [13] [10] [9] <Insert number> percent.
 4. Finger Jointing: [Allowed] [Not allowed].
 5. Face Surface: [Surfaced (smooth)] [Saw textured].
 6. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.
- E. Softwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings. Made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."
1. Species: [Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine] [Southern pine] [Western red cedar] [Douglas fir] <Insert species>.
 2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 3. Finger Jointing: Not allowed.
 4. Matching: Selected for compatible grain and color.
 5. Base Pattern: [WM 623, 9/16-by-3-1/4-inch ogee] [WM 713, 9/16-by-3-1/4-inch ranch] [WM 753, 9/16-by-3-1/4-inch beaded-edge] [WM 620, 9/16-by-4-1/4-inch ogee] [WM 750, 9/16-by-4-1/4-inch beaded-edge] base.
 6. Shoe-Mold Pattern: [WM 129, 7/16-by-11/16-inch quarter-round] [WM 126, 1/2-by-3/4-inch quarter-round] [WM 131, 1/2-by-3/4-inch ogee] shoe mold.
 7. Casing Pattern: [WM 327, 11/16-by-2-1/4-inch clamshell] [WM 366, 11/16-by-2-1/4-inch featheredge] [WM 376, 11/16-by-2-1/4-inch beaded-edge] casing.
 8. Mull-Casing Pattern: [WM 957, 3/8-by-1-3/4-inch beaded-edge] [WM 973, 3/8-by-1-3/4-inch bullnose] [WM 983, 3/8-by-1-3/4-inch featheredge] casing.
 9. Stop Pattern: [WM 856, 3/8-by-1-3/8-inch ranch] [WM 946, 3/8-by-1-3/8-inch ogee] [WM 886, 3/8-by-1-3/8-inch bullnose] stop.
 10. Chair-Rail Pattern: WM 297, 11/16-by-3-inch chair rail.
- F. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings made to patterns included in MMPA's "HWM/Series Hardwood Moulding Patterns."
1. Species: [Red oak] [White maple] [Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar] <Insert species>.
 2. Maximum Moisture Content: 9 percent.
 3. Finger Jointing: Not allowed.
 4. Matching: Selected for compatible grain and color.
 5. Optional Material: Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.

6. Base Pattern: [HWM 633, 7/16-by-3-1/4-inch ogee] [HWM 713, 7/16-by-3-1/4-inch ranch] [HWM 753, 7/16-by-3-1/4-inch beaded-edge] [WM 620, 7/16-by-4-1/4-inch ogee] base.
 7. Shoe-Mold Pattern: [HWM 129, 7/16-by-11/16-inch quarter-round] [HWM 126, 1/2-by-3/4-inch quarter-round] [HWM 131, 1/2-by-3/4-inch ogee] shoe mold.
 8. Casing Pattern: [HWM 328, 1/2-by-2-1/4-inch clamshell] [HWM 366, 1/2-by-2-1/4-inch featheredge] [HWM 376, 1/2-by-2-1/4-inch beaded-edge] casing.
 9. Mull-Casing Pattern: [HWM 989, 3/16-by-2-inch square-edge] [HWM 988, 3/8-by-1-1/2-inch featheredge] [HWM 987, 3/8-by-2-inch featheredge] casing.
 10. Stop Pattern: [HWM 856, 3/8-by-1-3/8-inch ranch] [HWM 946, 3/8-by-1-3/8-inch ogee] [HWM 886, 3/8-by-1-3/8-inch bullnose] stop.
 11. Chair-Rail Pattern: HWM 297, 11/16-by-3-inch chair rail.
- G. Moldings for Opaque Finish (Painted Finish): Made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."
1. Softwood Moldings: MMPA WM 4, P grade.
 - a. Species: [Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine] <Insert species>.
 - b. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 2. Hardwood Moldings: MMPA WM 4, P-grade.
 - a. Species: [Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar] <Insert species>.
 - b. Maximum Moisture Content: 9 percent.
 3. Finger Jointing: [Allowed] [Not allowed].
 4. Optional Material: Primed MDF.
 5. Base Pattern: [WM 623, 9/16-by-3-1/4-inch ogee] [WM 713, 9/16-by-3-1/4-inch ranch] [WM 753, 9/16-by-3-1/4-inch beaded-edge] [WM 620, 9/16-by-4-1/4-inch ogee] [WM 750, 9/16-by-4-1/4-inch beaded-edge] base.
 6. Shoe-Mold Pattern: [WM 129, 7/16-by-11/16-inch quarter-round] [WM 126, 1/2-by-3/4-inch quarter-round] [WM 131, 1/2-by-3/4-inch ogee] shoe mold.
 7. Casing Pattern: [WM 327, 11/16-by-2-1/4-inch clamshell] [WM 366, 11/16-by-2-1/4-inch featheredge] [WM 376, 11/16-by-2-1/4-inch beaded-edge] casing.
 8. Mull-Casing Pattern: [WM 957, 3/8-by-1-3/4-inch beaded-edge] [WM 973, 3/8-by-1-3/4-inch bullnose] [WM 983, 3/8-by-1-3/4-inch featheredge] casing.
 9. Stop Pattern: [WM 856, 3/8-by-1-3/8-inch ranch] [WM 946, 3/8-by-1-3/8-inch ogee] [WM 886, 3/8-by-1-3/8-inch bullnose] stop.
 10. Chair-Rail Pattern: WM 297, 11/16-by-3-inch chair rail.
- H. PVC-Wrapped Moldings: MMPA WM 2 and made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."
1. Base Pattern: [WM 623, 9/16-by-3-1/4-inch ogee] [WM 713, 9/16-by-3-1/4-inch ranch] base.

2. Shoe-Mold Pattern: [WM 129, 7/16-by-11/16-inch quarter-round] [WM 126, 1/2-by-3/4-inch quarter-round] shoe mold.
 3. Casing Pattern: [WM 327, 11/16-by-2-1/4-inch clamshell] [WM 366, 11/16-by-2-1/4-inch featheredge] casing.
 4. Mull-Casing Pattern: [WM 973, 3/8-by-1-3/4-inch bullnose] [WM 983, 3/8-by-1-3/4-inch featheredge] casing.
 5. Stop Pattern: [WM 856, 3/8-by-1-3/8-inch ranch] [WM 886, 3/8-by-1-3/8-inch bullnose] stop.
 6. Chair-Rail Pattern: WM 297, 11/16-by-3-inch chair rail.
 7. Colors, Textures, and Grain Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].
- I. Foam-Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces are not to be shaped after molding.
1. Density: Not less than 20 lb/cu. ft..
 2. Flame-Spread Index: Not more than [75] <Insert number> when tested according to ASTM E84.
 3. Thickness: Not more than 1/2 inch.
 4. Width: Not more than 8 inches.
 5. Patterns: [As indicated by manufacturer's designations] [Match Architect's samples].

PANELING

- J. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.
1. Face Veneer Species and Cut: [Rotary-cut white birch] [Plain-sliced red oak] [Plain-sliced hickory] <Insert species and cut>.
 2. Veneer Matching: [Random match] [Selected for similar color and grain].
 3. Backing Veneer Species: [Same species as face veneer] [Any hardwood compatible with face species].
 4. Construction: Veneer core.
 5. Thickness: [1/8 inch] [5/32 inch] [3/16 inch] [1/4 inch] [5/16 inch] [7/16 inch].
 6. Panel Size:
 - a. [48 by 96 inches] [48 by 120 inches].
 - b. [1200 by 2400 mm] [1200 by 3000 mm].
 7. Glue Bond: Type II (interior).
 8. Face Pattern: Manufacturer's standard [V] [channel]-grooved pattern, with grooves at edges, center, and third points of panels, and at other locations to provide pattern resembling random-width boards.
 9. Finish: [Manufacturer's standard, transparent, UV-resistant, protective finish] [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

Hardboard Paneling: Interior factory-finished hardboard paneling complying with ANSI A135.5.

10. Thickness: [1/8 inch] [5/32 inch] [1/4 inch].
 11. Finish: [Class I] [Class II].
 12. Surface-Burning Characteristics: As follows, tested according to ASTM E84:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 13. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].
- K. Board Paneling, MMPA: Interior wood-board paneling complying with MMPA WM 9.
1. Species: [Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine] [Southern pine] [Western red cedar] [Figured red gum] <Insert species>.
 2. Grade: [Clear No. 1] [Clear No. 2] [Knotty No. 1] [Knotty No. 2] [Finger jointed].
 3. Maximum Moisture Content: [15 percent with at least 85 percent of shipment at 12 percent or less] [9 percent].
 4. Pattern: [V-joint, tongue and groove, PT 82] [Beaded ceiling, PT 85] [Beveled-edge channel, shiplapped, PT 82] [As indicated].
 5. Net Coverage Width: Not less than [5-1/16 inches] [6-3/4 inches] [8-3/4 inches].
- L. Board Paneling:
1. Species and Grade:
 - a. Eastern white pine; NeLMA or NLGA [C Select] [D Select] [Finish or 1 Common] [Premium or 2 Common].
 - b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [C Select (Choice)] [D Select (Quality)] [1 Common (Colonial)] [2 Common (Sterling)].
 - c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [C Select (Choice)] [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)].
 - d. Southern pine; SPIB [B & B] [C & Btr] [No. 2] Paneling.
 - e. Western red cedar; NLGA, WCLIB, or WWPA [Clear Heart] [Grade A] [Grade B].
 2. Maximum Moisture Content: [19] [15] percent [with at least 85 percent of shipment at 12 percent or less].
 3. Pattern:
 - a. V-joint, tongue and groove, [NeLMA EWP 4] [SPIB SPP 54] [or] [WWPA WP 4].
 - b. Pickwick, tongue and groove, [NeLMA EWP 2] [SPIB SPP 52] [or] [WWPA WP 2].
 - c. Rounded-edge channel groove, tongue and groove, [SPIB SPP 60] [or] [WWPA WP 6].
 - d. Edge and center bead, tongue and groove, [NeLMA E & CB] [or] [WWPA E & CB Ceiling].
 4. Net Coverage Width: Not less than [5-1/16 inches] [6-3/4 inches] [8-3/4 inches].

SHELVING AND CLOTHES RODS

- M. Shelving: [Exposed] [Closet] [Utility] shelving, made from [the following material] [one of the following materials], 3/4 inch thick:
1. Particleboard with [radiused and filled] [or] [solid-wood] front edge.
 2. MDF with [radiused] [or] [solid-wood] front edge.
 3. MDO softwood plywood with solid-wood edge.
 4. Melamine-faced particleboard with [radiused and filled] [applied-PVC] front edge.
 5. Wood boards as specified above for [lumber trim for opaque] [softwood lumber trim for transparent] [hardwood lumber trim for transparent] finish.
 6. Softwood Boards:
 - a. Kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [C Select (Choice)] [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)].
 - b. Kiln-dried Douglas fir-larch, Douglas fir south, or hem-fir; SPIB [Superior or C & Btr] [Prime or D] finish; NLGA, WCLIB, or WWPA; or southern pine; [B & B] [C] finish.
- N. Shelf Cleats: [3/4-by-3-1/2-inch boards] [3/4-by-5-1/2-inch boards] [3/4-by-5-1/2-inch boards with hole and notch to receive clothes rods], as specified above for [shelving] [lumber trim for opaque finish] [softwood lumber trim for transparent finish] [hardwood lumber trim for transparent finish].
- O. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
- P. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.
- Q. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; [powder-coat-finished] [brass-finished] [zinc-plated] steel.
- R. Adjustable Shelf Brackets: BHMA A156.9, B04112; [powder-coat-finished steel] [brass-finished steel] [zinc-plated steel] [bronze-anodized aluminum] [black-anodized aluminum] [natural aluminum].
- S. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; [powder-coat-finished] [brass-finished] [zinc-plated] steel.
- T. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; [powder-coat-finished] [brass-finished] [zinc-plated] steel.
- U. Wood Clothes Rods: 1-1/2-inch-diameter, clear, kiln-dried [hardwood] [Douglas fir or southern pine].
- V. Metal Clothes Rods: 1-5/16-inch-diameter, [aluminum tubes] [chrome-plated-steel tubes] [color-coated-steel tubes] [stainless steel tubes] [chrome-plated-steel telescoping tubes with end brackets for mounting on shelf cleats].
- W. Wood Rod Flanges: Clear, kiln-dried, [Douglas fir or southern pine] [eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine] [red oak] [white maple] [aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar] <Insert species> turnings [with clear finish].

- X. Metal Rod Flanges: [Aluminum] [Chrome-plated steel] [Stainless steel].

MISCELLANEOUS MATERIALS

- Y. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- Z. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
- AA. Installation Adhesive for Foam-Plastic Moldings: Product recommended for indicated use by foam-plastic molding manufacturer.
- BB. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.
- CC. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended for indicated use by adhesive manufacturer.

FABRICATION

- DD. Back out or kerf backs of the following members, except those with ends exposed in finished work:
 - 1. Interior standing and running trim, except shoe and crown molds.
 - 2. Wood-board paneling.
- EE. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 EXECUTION

EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION

- D. Clean substrates of projections and substances detrimental to application.
- E. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours [unless longer conditioning is recommended by manufacturer].

INSTALLATION, GENERAL

- F. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.
- G. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

INSTALLATION OF INTERIOR TRIM

- H. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.
 - 1. Do not use pieces less than 24 inches long, except where necessary.
 - 2. Stagger joints in adjacent and related standing and running trim.
 - 3. [Cope] [Miter] at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
 - 4. Use scarf joints for end-to-end joints.
 - 5. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
 - 6. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
 - 7. Install trim after gypsum-board joint finishing operations are completed.
 - 8. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
 - 9. Fasten to prevent movement or warping.
 - 10. Countersink fastener heads on exposed carpentry work and fill holes.

INSTALLATION OF PANELING

- I. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels.
 - 1. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings.
 - 2. Install with uniform tight joints between panels.

3. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners.
 4. Space fasteners and adhesive as recommended by panel manufacturer.
 5. Conceal fasteners to greatest practical extent.
 6. Arrange panels with grooves and joints over supports.
 - a. Fasten to supports with nails of type and at spacing recommended by panel manufacturer.
 - b. Use fasteners with prefinished heads matching groove color.
- J. Hardboard Paneling: Install according to manufacturer's written instructions.
1. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings.
 2. Butt adjacent panels with moderate contact.
 3. Use fasteners with prefinished heads matching paneling color.
 4. Wood Stud or Furring Substrate: Install with 1-inch annular-ring shank hardboard nails.
 5. Plaster or Gypsum-Board Substrate: Install with 1-5/8-inch annular-ring shank hardboard nails.
 6. Nailing: Space nails 4 inches o.c. at panel perimeter and 8 inches o.c. at intermediate supports unless otherwise required by manufacturer.
- K. Board Paneling: Install according to manufacturer's written instructions.
1. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
 2. Install in full lengths without end joints.
 3. Stagger end joints in random pattern to uniformly distribute joints on each wall.
 4. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
 5. Install with uniform end joints. Locate end joints only over furring or blocking.
 6. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards.
 7. Install with uniform tight joints between boards.
 8. Fasten paneling by face nailing, setting nails, and filling over nail heads.
 9. Fasten paneling with trim screws, set below face and filled.
 10. Fasten paneling by blind nailing through tongues.
 11. Fasten paneling with paneling system manufacturer's concealed clips.
 12. Fasten paneling to gypsum wallboard with panel adhesive.

INSTALLATION OF SHELVING AND CLOTHES RODS

- L. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.
1. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled.

2. Space fasteners not more than 16 inches o.c. [Use two fasteners at each framing member or fastener location for cleats 4 inches nominal in width and wider.]
 3. Apply a bead of multipurpose construction adhesive to back of shelf cleats before installing.
 4. Remove adhesive that is squeezed out after fastening shelf cleats in place.
- M. Install shelf brackets according to manufacturer's written instructions, spaced not more than [32 inches] [36 inches] o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- N. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches o.c.
- O. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches o.c. and within 6 inches of ends of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- P. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled.
1. Install shelves, fully seated on cleats, brackets, and supports.
 2. Fasten shelves to cleats with finish nails or trim screws, set flush.
 3. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
- Q. Install rod flanges for rods as indicated.
1. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
 2. Install rods in rod flanges.

ADJUSTING

- R. Replace interior finish carpentry that is damaged or does not comply with requirements.
1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- S. Adjust joinery for uniform appearance.

CLEANING

- T. Clean interior finish carpentry on exposed and semiexposed surfaces.
- U. Restore damaged or soiled areas and touch up factory-applied finishes if any.

PROTECTION

- V. Protect installed products from damage from weather and other causes during construction.

- W. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 06 41 13

WOOD-VENEER-FACED ARCHITECTURAL CABINETS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wood cabinets for transparent finish.
2. Wood cabinets for opaque finish.
3. Wood materials.
4. Fire-retardant-treated material.
5. Cabinet hardware and accessories.
6. Miscellaneous materials.
7. Shop finishing.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.02 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 08 71 00 "Door Hardware" to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Wood cabinets for transparent finish.
2. Wood cabinets for opaque finish.
3. Wood materials.
4. Fire-retardant-treated material.
5. Cabinet hardware and accessories.
6. Miscellaneous materials.

7. Shop finishing.
- B. Product Data Submittals: For each product.
1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- C. Shop Drawings: For architectural cabinets.
1. Comply with NAAWS standards.
 2. Include plans, elevations, sections, and attachment details.
 3. Show large-scale details.
 4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 5. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
 6. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
 7. Apply NAAWS Certified Compliance Program label to Shop Drawings.
- D. Samples: For each exposed product and for each color and finish specified, in manufacturer's standard size.
- E. Samples for Initial Selection: For each type of exposed finish.
- F. Samples for Verification: For the following:
1. Lumber for Transparent Finish: Not less than **[5 inches wide by 12 inches long]** **[5 inches wide by 24 inches long]**, for each species and cut, finished on one side and one edge.
 2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished cabinets.
 3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches wide by 12 inches long for lumber and **[8 by 10 inches]** **[12 by 12 inches]** for panels, for each finish system and color.
 4. Finish **[entire]** **[one-half of]** exposed surface.
 5. Thermally Fused Laminate (TFL) Panels: **[8 by 10 inches]** **[12 by 12 inches]**, for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
 6. Corner Pieces:
 - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 7. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For [manufacturer] [and] [Installer].
- B. Product Certificates: For [each type of product.] [the following:]

1. Composite wood products.
 2. Thermally fused laminate panels.
 3. Glass.
 4. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
- A. Quality Standard Compliance Certificates: NAAWS Certified Compliance Program certificates.
- 1.07 QUALITY ASSURANCE
- A. General: Work shall be in accordance with NAAWS standards for the grade or grades specified.
- B. Certified compliance:
1. Before delivery to the jobsite the woodwork supplier shall provide a NAAWS Certified Compliance Certificate indicating the millwork products being supplied and certifying that these products fully meet the requirements of the Grade or Grades specified.
 2. Each elevation of casework shall bear a NAAWS Certified Compliance label.
 3. At completion of installation the woodwork installer shall provide a NAAWS Certified Compliance certificate indicating the products installed and certifying that the installation of these products fully meets the requirements of the Grade or Grades specified.
 4. Fees charged by NAAWS for their Certified Compliance program shall be included in the Contractor's bid.
- C. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- D. Certified Seismic Installation Program:
1. Before walls are closed up, provide a written Woodwork Institute Certified Seismic Installation Program report confirming that backing is provided in all locations required for casework installation or identifying those locations where backing is missing or improperly located.
 2. On completion of installation, provide a Woodwork Institute Certified Seismic Installation Program Certificate identifying the work covered and certifying the installations meets the requirements of the NAAWS CSIP attachment details and schedules.
 3. All fees charge by the Woodwork Institute for its Certified Seismic Installation Program are the responsibility of the millwork installer and shall be included in their bid.
 4. In the event there is a conflict between the Contract Documents and the CSIP HCAI-approved OPM Drawings, the CSIP HCAI-approved OPM Drawings and Certified Seismic Installation Program shall prevail.
- E. Installer Qualifications: [Manufacturer of products] [Licensed participant in NAAWS's Certified Compliance Program].

- F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups of [typical architectural cabinets as shown on Drawings] <Insert description>.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.09 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 20 and 50 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.01 ARCHITECTURAL CABINETS

- A. Source Limitations: Engage a qualified woodworking firm to assume responsibility for production of architectural cabinets with sequence-matched wood veneers **[wood paneling] [wood doors with face veneers that are sequence matched with architectural cabinets] [and] [transparent-finished wood doors that are required to be of same species as architectural cabinets]**.
- B. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. <Insert, in separate subparagraphs, names of preapproved woodworking firms>.

2.02 CABINETS, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the North American North American Architectural Woodwork Standards for grades of architectural cabinets indicated for construction, finishes, installation, and other requirements.
1. Provide **[labels] [and] [certificates]** from **[NAAWS]** certification program indicating that woodwork **[and installation]** complies with requirements of grades specified.
 - a. This Project has been registered with NAAWS as NAAWS Quality Certification Program Number **<Insert number>**.
 2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

2.03 WOOD CABINETS FOR TRANSPARENT FINISH

- A. North American Architectural Woodwork Standards Grade: **[Premium] [Custom] [Economy]**.
- B. Type of Construction: **[Frameless] [Face frame]**.
- C. Door and Drawer-Front Style: **[Flush overlay] [Reveal overlay] [Lipped] [Flush inset]**.
1. Reveal Dimension: **[1/2 inch] [As indicated on Drawings] <Insert dimension>**.
- D. Wood for Exposed Surfaces: **[As indicated on Drawings.]**
1. Species: **[Red oak] [White oak] [White ash] [White birch] <Insert species>**.
 2. Blueprint Matching: Comply with veneer and other matching requirements indicated for blueprint-matched paneling.
 3. Cut: **[Plain sliced/plain sawn] [Rift cut/rift sawn] [Quarter cut/quarter sawn]**.
 4. Grain Direction: **[Vertically for drawer fronts, doors, and fixed panels] [Horizontally for drawer fronts, doors, and fixed panels] [Vertically for doors and fixed panels, horizontally for drawer fronts] [As indicated on Drawings]**.
 5. Matching of Veneer Leaves: **[Book] [Slip] [Random] match**.
 6. Veneer Matching within Panel Face: **[Running] [Balance] [Center-balance] match**.
 7. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
- E. Semiexposed Surfaces:
1. Surfaces Other Than Drawer Bodies: **[Same species and cut indicated for exposed surfaces] [Thermally fused laminate panels] [Compatible species to that indicated for exposed surfaces, stained to match] <Insert requirements>**.
 - a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
 2. Drawer Subfronts, Backs, and Sides: **[Solid-hardwood lumber, same species indicated for exposed surfaces] [Solid-hardwood lumber, stained to match species indicated for exposed surfaces] [Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding] <Insert requirements>**.
 3. Drawer Bottoms: **[Hardwood plywood] [Thermally fused laminate panels] <Insert requirements>**.

- F. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- G. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with [glued rabbeted joints supplemented by mechanical fasteners] [or] [glued dovetail joints].

2.04 WOOD CABINETS FOR OPAQUE FINISH

- A. North American North American Architectural Woodwork Standards Grade: **[Premium]** **[Custom]** **[Economy]**.
- B. Type of Construction: [Frameless] [Face frame].
- C. Door and Drawer-Front Style: [Flush overlay] [Reveal overlay] [Lipped] [Flush inset].
 - 1. Reveal Dimension: **[1/2 inch]** [As indicated on Drawings] <Insert dimension>.
- D. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.
- E. Panel Product for Exposed Surfaces: **[MDF]** **[Medium-density overlay]**.
- F. Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: [Match materials indicated for exposed surfaces] [Thermally fused laminate panels] <Insert requirements>.
 - a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
 - 2. Drawer Sides and Backs: [Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding] <Insert requirements>.
 - 3. Drawer Bottoms: [Hardwood plywood] [Thermally fused laminate panels] <Insert requirements>.
- G. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with [glued rabbeted joints supplemented by mechanical fasteners] [or] [glued dovetail joints].

2.05 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches wide.
 - 2. Wood Moisture Content: 4 to 9 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Medium-Density Fiberboard (MDF): ANSI A208.2, **[Grade 130] <Insert grade>**.
2. Particleboard (Medium Density): ANSI A208.1, **[Grade M-2] [Grade M-2-Exterior Glue]**.
3. Softwood Plywood: DOC PS 1 **[, medium-density overlay]**.
4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
5. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper **[and complying with requirements of ISO 4586]**.

2.06 FIRE-RETARDANT-TREATED MATERIAL

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.
1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.

2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

2.07 CABINET HARDWARE AND ACCESSORIES

- A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware".
- B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
 2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening, self-closing.
- D. Accessories Basis of Design:
1. Cabinet Drawer Glides: Accuride 3832
 2. Cabinet Hinges: Rockford Process Control (RPC) #851
 3. Cabinet Locks: Best L Series Deadbolts and Strikes
 4. Cabinet Magnetic Catches: Epco #591
 5. Cabinet Pulls: Trimco 562-4
 6. Cabinet Shelf Standards: Knappe & Vogt (KV) 255 standards and 256 shelf clips
 7. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- E. Slides for Sliding Glass Doors: ANSI/BHMA A156.9, B07063; **[plastic] [aluminum]**.
- F. Door Locks: ANSI/BHMA A156.11, E07121.
- G. Drawer Locks: ANSI/BHMA A156.11, E07041.
- H. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- I. Float Glass for Cabinet Doors: ASTM C1036, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3.
1. Thickness: **[3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm]**.
 2. Tint Color: **[Blue-green] [Bronze] [Green] [Gray] <Insert color>**.
- J. Tempered Float Glass for Cabinet Doors: ASTM C1048, Kind FT, Condition A, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3, 6 mm thick unless otherwise indicated.
1. Tint Color: **[Blue-green] [Bronze] [Green] [Gray] <Insert color>**.
 2. Unframed Glass Doors: Seam exposed edges seamed before tempering.

- K. Mirror Glass for Cabinet Doors: ASTM C1503, Mirror **[Select] [Glazing]**, Quality-Q3.
1. Thickness: **[3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm]**.
- L. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Section 08 81 13 "Decorative Glass Glazing."
- M. Tempered Float Glass for Cabinet Shelves: ASTM C1048, Kind FT, Condition A, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.
1. Tint Color: **[Blue-green] [Bronze] [Green] [Gray]** <Insert color>.
- N. Grommets for Cable Passage: **[1-1/4-inch] [2-inch]** <Insert dimension> OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Color: **[Brown] [Black]** <Insert color>.
- O. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated.
1. Dark, Oxidized, Satin Bronze, Oil Rubbed: ANSI/BHMA 613 for bronze base; ANSI/BHMA 640 for steel base; match Architect's sample.
 2. Bright Brass, Clear Coated: ANSI/BHMA 605 for brass base; ANSI/BHMA 632 for steel base.
 3. Bright Brass, Vacuum Coated: ANSI/BHMA 723 for brass base; ANSI/BHMA 729 for zinc-coated-steel base.
 4. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
 5. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
 6. Bright Chromium Plated: ANSI/BHMA 625 for brass or bronze base; ANSI/BHMA 651 for steel base.
 7. Satin Stainless Steel: ANSI/BHMA 630.
- P. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.08 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: **[Softwood or hardwood lumber] [Fire-retardant-treated softwood lumber]**, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.09 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch radius unless otherwise indicated.

- C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- E. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in wood frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

2.10 SHOP FINISHING

- A. Finish architectural cabinets at manufacturer's shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Shop-finish transparent-finished architectural cabinets at manufacturer's shop as specified in this Section.
- C. Drawings indicate items that are required to be shop finished. Finish these items at manufacturer's shop as specified in this Section. See Section 09 90 00 Painting for field finishing of architectural cabinets.
- D. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural cabinets, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.
- E. Transparent Finish:
 - 1. North American North American Architectural Woodwork Standards Grade: [Premium] [Custom] [Economy] [Same as item to be finished].
 - 2. Finish: System - [1, nitrocellulose lacquer] [2, precatylyzed lacquer] [3, postcatylyzed lacquer] [4, water-based latex acrylic] [5, conversion varnish] [6, synthetic penetrating oil] [7, catalyzed vinyl] [8, water-based crosslinking acrylic] [9, UV-curabile acrylated epoxy, polyester, or urethane] [10, water-based UV curabile] [11, catalyzed polyurethane] [12, water-based polyurethane] [13, catalyzed polyester].
 - 3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
 - 4. Staining: [None required] [Match approved sample for color] [Match Architect's sample].

5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
6. Filled Finish for Open-Grain Woods: [After staining, apply wash-coat sealer and allow to dry.] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
7. Sheen: [Flat, 15-30] [Satin, 31-45] [Semigloss, 46-60] [Gloss, 61-100] gloss units measured on 60-degree gloss meter per ASTM D523.

F. Opaque Finish:

1. North American North American Architectural Woodwork Standards Grade: [Premium] [Custom] [Economy] [Same as item to be finished].
2. Finish: System - [1, nitrocellulose lacquer] [2, precatylyzed lacquer] [3, postcatylyzed lacquer] [4, water-based latex acrylic] [5, conversion varnish] [7, catalyzed vinyl] [8, water-based crosslinking acrylic] [9, UV-curable acrylated epoxy, polyester, or urethane] [10, water-based UV curable] [11, catalyzed polyurethane] [12, water-based polyurethane] [13, catalyzed polyester].
3. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range].
4. Sheen: [Flat, 15-30] [Satin, 31-45] [Semigloss, 46-60] [Gloss, 61-100] gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 EXECUTION

3.01 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION

- A. North American North American Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails [**or finishing screws**] for exposed fastening, countersunk and filled flush with cabinet surface.
 1. For shop-finished items, use filler matching finish of items being installed.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 3. Maintain veneer sequence matching of cabinets with transparent finish.

4. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with [No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips] [No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish] [toggle bolts through metal backing or metal framing behind wall finish].
- E. Shop Finishes: Touch up finishing after installation of architectural cabinets. Fill nail holes with matching filler.
 1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.
- F. Field Finishing: See [Section 09 91 23 "Interior Painting"] [and] [Section 09 93 00 "Staining and Transparent Finishing"] for finishing of installed architectural cabinets.

3.03 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through NAAWS's Certified Compliance Program certifying that woodwork, including installation, complies with requirements of the North American North American Architectural Woodwork Standards for the specified grade.
 1. Inspection entity is to prepare and submit report of inspection.
- B. Provide Woodwork Institute Certified Seismic Installation System inspection reports and certificates as specified in part 1 of this section.

3.04 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semi-exposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 41 16

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.02 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 08 71 00 "Door Hardware" to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.03 PRE-INSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Action submittals are submittals requiring responsive action and return of reviewed documents to Contractor. Product Data:
 1. Plastic-laminate-clad architectural cabinets.
 2. Cabinet hardware and accessories.
 3. Miscellaneous materials.
- C. Product Data Submittals: For each product.
 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- D. Comply with NAAWS standards.
- E. Shop Drawings:
 1. Comply with NAAWS standards.

2. Include plans, elevations, sections, and attachment details.
 3. Show large-scale details.
 4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 5. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
 6. Apply NAAWS Certified Compliance Program label to Shop Drawings.
- F. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
- G. Samples for Initial Selection: For each type of exposed finish.
- H. Samples for Verification: For the following:
1. Plastic Laminates: **[8 by 10 inches] [12 by 12 inches]**, for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.
 2. Thermally Fused Laminate (TFL) Panels: **[8 by 10 inches] [12 by 12 inches]**, for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
 3. Corner Pieces:
 - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For **[manufacturer] [and] [Installer]**.
- B. Product Certificates: For **[each type of product.] [the following:]**
1. Composite wood products.
 2. Thermally fused laminate panels.
 3. High-pressure decorative laminate.
 4. Glass.
 5. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
- A. Quality Standard Compliance Certificates: NAAWS Certified Compliance Program certificates.
- 1.07 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
 - 1. Manufacturer's Certification: Licensed participant in NAAWS's Certified Compliance Program.
- B. Certified Seismic Installation Program:
 - 1. Before walls are closed up, provide a written NAAWS Certified Seismic Installation Program report confirming that backing is provided in all locations required for casework installation or identifying those locations where backing is missing or improperly located.
 - 2. On completion of installation, provide a NAAWS Certified Seismic Installation Program Certificate identifying the work covered and certifying the installations meets the requirements of the NAAWS CSIP attachment details and schedules.
 - 3. All fees charge by the NAAWS for its Certified Seismic Installation Program are the responsibility of the millwork installer and shall be included in their bid.
 - 4. In the event there is a conflict between the Contract Documents and the CSIP HCAI-approved OPM Drawings, the CSIP HCAI-approved OPM Drawings and Certified Seismic Installation Program shall prevail.
- C. Installer Qualifications: [Manufacturer of products] [Licensed participant in NAAWS's Certified Compliance Program].
- D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups of [typical architectural cabinets as shown on Drawings] <Insert description>.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.09 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 20 and 50 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 ARCHITECTURAL CABINETS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

2.03 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the NAAWS Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
1. Provide **[labels]** **[and]** **[certificates]** from **[NAAWS]** certification program indicating that **woodwork [and installation]** complies with requirements of grades specified.
 2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Plastic Laminate manufacturer:
1. Panolam/Nevamar.
 2. Formica.
 3. Wilsonart.
 4. Or Equal
- C. NAAWS Standards Grade: **[Premium]** **[Custom]** **[Economy]**.
- D. Type of Construction: **[Frameless]** **[Face frame]**.
- E. Door and Drawer-Front Style: **[Flush]** **[Reveal]** overlay.
1. Reveal Dimension: **[1/2 inch]** **[As indicated]** <Insert dimension>.
- F. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.
- G. Exposed Surfaces:
1. Plastic-Laminate Grade: **[HGS]** **[VGS]** **[HGP]**.

2. Edges: [Grade HGS] [Grade VGS] [PVC tape, **0.018-inch** minimum thickness, matching laminate in color, pattern, and finish] [PVC T-mold matching laminate in color, pattern, and finish] [PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish].
3. Pattern Direction: [Vertically for drawer fronts, doors, and fixed panels] [Horizontally for drawer fronts, doors, and fixed panels] [Vertically for doors and fixed panels, horizontally for drawer fronts] [As indicated].

H. Semi-exposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [High-pressure decorative laminate, ISO 4586-3] [Thermally fused laminate panels].
 - a. Edges of Plastic-Laminate Shelves: [PVC tape, **0.018-inch** minimum thickness, matching laminate in color, pattern, and finish] [PVC T-mold matching laminate in color, pattern, and finish] [PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish].
 - b. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
 - c. For semi-exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, ISO 4586-3, grade to match exposed surface.
2. Drawer Sides and Backs: [Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding].
3. Drawer Bottoms: [Hardwood plywood] [Thermally fused laminate panels].

I. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

J. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, ISO 4583-3, grade to match exposed surface.

K. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with [glued rabbeted joints supplemented by mechanical fasteners] [or] [glued dovetail joints].

L. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.
2. Match Architect's sample.
3. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, [gloss] [matte] finish.
 - b. Solid colors with core same color as surface, [gloss] [matte] finish.
 - c. Wood grains, [gloss] [matte] finish.
 - d. Patterns, [gloss] [matte] finish.

2.04 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 4 to 9 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, **[Grade 130]** <Insert grade>.
 - 2. Particleboard (Medium Density): ANSI A208.1, **[Grade M-2]** **[Grade M-2-Exterior Glue]**.
 - 3. Softwood Plywood: DOC PS 1[, **medium-density overlay**].
 - 4. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper[**and complying with requirements of ISO 4586**].

2.05 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.
 - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 - 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less in accordance with ASTM E84.

1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
 2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

2.06 CABINET HARDWARE AND ACCESSORIES

- A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware".
- B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
 2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening, self-closing.
- D. Accessories Basis of Design:
1. Cabinet Drawer Glides: Accuride 3832
 2. Cabinet Hinges: Rockford Process Control (RPC) #851
 3. Cabinet Locks: Best L Series Deadbolts and Strikes
 4. Cabinet Magnetic Catches: Epco #591
 5. Cabinet Pulls: Trimco 562-4
 6. Cabinet Shelf Standards: Knap & Vogt (KV) 255 standards and 256 shelf clips
 7. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- E. Float Glass for Cabinet Doors: ASTM C1036, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3.
1. Thickness: **[3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm]**.
 2. Tint Color: **[Blue-green] [Bronze] [Green] [Gray]** <Insert color>.
- F. Tempered Float Glass for Cabinet Doors: ASTM C1048, Kind FT, Condition A, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3, 6 mm thick unless otherwise indicated.
1. Tint Color: **[Blue-green] [Bronze] [Green] [Gray]** <Insert color>.
 2. Unframed Glass Doors: Seam exposed edges seamed before tempering.
- G. Mirror Glass for Cabinet Doors: ASTM C1503, Mirror **[Select] [Glazing]**, Quality-Q3.
1. Thickness: **[3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm]**.

- H. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Section 08 81 13 "Decorative Glass Glazing."
- I. Tempered Float Glass for Cabinet Shelves: ASTM C1048, Kind FT, Condition A, Type I, **[Class 1 (clear)] [Class 2 or 3 (tinted)]**, Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.
 - 1. Tint Color: **[Blue-green] [Bronze] [Green] [Gray]** <Insert color>.
- J. Grommets for Cable Passage: **[1-1/4-inch] [2-inch]** <Insert dimension> OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: **[Brown] [Black]** <Insert color>.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Dark, Oxidized, Satin Bronze, Oil Rubbed: ANSI/BHMA 613 for bronze base; ANSI/BHMA 640 for steel base; match Architect's sample.
 - 2. Bright Brass, Clear Coated: ANSI/BHMA 605 for brass base; ANSI/BHMA 632 for steel base.
 - 3. Bright Brass, Vacuum Coated: ANSI/BHMA 723 for brass base; ANSI/BHMA 729 for zinc-coated-steel base.
 - 4. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
 - 5. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
 - 6. Bright Chromium Plated: ANSI/BHMA 625 for brass or bronze base; ANSI/BHMA 651 for steel base.
 - 7. Satin Stainless Steel: ANSI/BHMA 630.
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.07 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: **[Softwood or hardwood lumber] [Fire-retardant-treated softwood lumber]**, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesive for Bonding Plastic Laminate: **[Type I, waterproof type] [Type II water-resistant type]** as selected by fabricator to comply with requirements.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive **[or adhesive specified above for faces]**.

2.08 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

PART 3 EXECUTION

3.01 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION

- A. NAAWS Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with [No. 10 wafer-head screws sized for not less than **1-1/2-inch** penetration into wood framing, blocking, or hanging strips] [No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish] [toggle bolts through metal backing or metal framing behind wall finish].

3.03 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through **[NAAWS's Certified Compliance Program]** certifying that woodwork, including installation, complies with requirements of the NAAWS Standards for the specified grade.
 1. Inspection entity is to prepare and submit report of inspection.
- B. Provide NAAWS Certified Seismic Installation System inspection reports and certificates as specified in part 1 of this section.

3.04 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semi-exposed surfaces.

END OF SECTION

SECTION 06 83 16
FRP WALL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Fiberglass reinforced polyester (FRP) wall panels.
 - 2. Matching moldings, fasteners, adhesive, and sealant.
- B. Related requirements: All other sealants.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing:
- B. Preinstallation meeting:

1.03 SUBMITTALS

- A. Samples: 12-inch square Samples of panel and 12-inch lengths of each profile of moldings.
- B. Shop Drawings: Shop Drawings showing panel joint locations and details. Joint locations are subject to the Architect's approval.
- C. Data: Manufacturer Product Data including testing laboratory certification of fire hazard classification on each package.
- D. Maintenance instructions:
 - 1. Copy of the panel manufacturer's maintenance instructions.
 - 2. Include recommended cleaning materials and methods of application therefore together with precautions in cleaning materials' use if such are improperly applied.

1.04 HANDLING

- A. Store panels indoor, and flat to avoid distortion. Maintain storage area temperature above 60-degree F.

1.05 JOB CONDITIONS

- A. Comply with wall panel manufacturer recommendations for temperature and humidity in installation areas.
- B. Illuminate work areas during installation to provide the same or greater level of illumination required to properly perform the work and as will occur in the room or space after the building is in operation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. FRP wall panel: By one of the following, furnished in longest length available to minimize joints, of the color selected by the Architect.
 - 1. Marlite Standard FRP panels, P 100 white, pebbled finish, basis of design.
 - 2. Crain Composites.
 - 3. Or equal.
- B. Trim: Manufacturer standard vinyl division bar, insider corner, outside corner and cap as required, matching the color of wall panel.
- C. Fasteners: Manufacturer standard rivets matching the color of the wall panel.
- D. Adhesive: Titebond "Fast Grab", or equal non-toxic, non-allergenic adhesive recommended by the wall panel manufacturer and meeting Code requirements for flammability and toxicity.
- E. Sealant: White, low gloss silicone, as specified in Section 07 92 00 unless otherwise recommended by panel manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces scheduled to receive wall panel for conditions that will adversely affect execution, permanence and quality of work. Verify that substrates are:
 - 1. Clean, smooth, dry, free of irregularities.
 - 2. Straight within a maximum tolerance of 1/8-inch in 10 feet, and not greater than 1/16-inch each running foot.

- B. Correct detrimental conditions before proceeding with installation.

3.02 MOLDING INSTALLATION

- A. Provide molding at top and bottom edges of panels. Use full-length stock moldings for run equaling, or less than, the stock length. Miter corners.
- B. Butt vertical edges tight and flush.
- C. Install panels plumb and level, and with hairline joints.

3.03 INSTALLATION OF PANELS

- A. Except as modified in this Section, comply with the panel manufacturer's installation instructions.
- B. Establish the top of the wainscot, or vertical terminations, in a straight line.
- C. Avoid contamination of panel faces.
- D. Butt joints for an even and tight fit along entire length of joint. Make joints plumb and level.
- E. Balance sheet width symmetrically about centerline of wall so that no sheet is less than 2-foot wide.
- F. Glue panels securely to substrate.
- G. Square cut and sand smooth edges that will not be covered by trim. Do not damage exposed face.
- H. Carefully locate penetrations and openings through the panels, including electrical outlets and piping, and provide minimum sized openings as required. Size openings so they will be covered by switch plates, flanges and other required trim.

3.04 CLEANING

- A. Remove excess sealant and adhesive from joint immediately.
- B. Clean installation immediately after installation with manufacturer recommended cleaner.
- C. Replace damaged or permanently contaminated units.

END OF SECTION

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DIVISION 07
THERMAL & MOISTURE PROTECTION

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SECTION 07 01 50

PREPARATION FOR RE-ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. The Work of This Section Includes:

1. Full roof tear-off.
2. Partial roof tear-off.
3. Temporary roofing.
4. Roof re-cover preparation.
5. Base flashing removal.
6. Fastener pull-out testing.
7. Disposal.

B. Related Requirements:

1. Section 01 10 00 "Summary" for use of premises and for phasing requirements.
2. Section 01 50 00 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.

1.02 DEFINITIONS

- A. EPS: Molded (expanded) polystyrene.
- B. Full Roof Tear-off: Removal of existing roofing system down to existing **[roof deck] [concrete fill]**.
- C. OSB: Oriented strand board.
- D. Partial Roof Tear-off: Removal of selected components and accessories from existing roofing system.
- E. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.
- F. Roof Re-Cover Preparation: Existing roofing system is to remain and be prepared for new roof installed over it.

1.03 PRE-INSTALLATION MEETINGS

- A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at **[Project site] <Insert location>**.
 1. Meet with Owner, Architect, **[Construction Manager,]** Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:
 - a. Reroofing preparation, including roofing system manufacturer's written instructions.
 - b. Temporary protection requirements for existing roofing system components that are to remain.
 - c. Existing roof drains and roof drainage during each stage of reroofing, and roof-drain plugging and plug removal.
 - d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.
 - e. Existing roof deck conditions requiring Architect notification.
 - f. Existing roof deck removal procedures and Owner notifications.
 - g. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
 - h. Structural loading limitations of roof deck during reroofing.
 - i. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.
 - j. HVAC shutdown and sealing of air intakes.
 - k. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
 - l. Asbestos removal and discovery of asbestos-containing materials.
 - m. Governing regulations and requirements for insurance and certificates if applicable.
 - n. Existing conditions that may require Architect notification before proceeding.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Temporary Roofing Submittal: Product data and description of temporary roofing system.
 1. If temporary roof remains in place, include surface preparation requirements needed to receive permanent roof, and submit a letter from roofing manufacturer stating acceptance of the temporary roof and that its inclusion does not adversely affect the new roofing system's resistance to fire and wind **[or specified special warranty] [or its FM Approvals rating]**.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
 1. Include certificate that Installer is approved by warrantor of existing roofing system.
 2. Include certificate that Installer is licensed to perform asbestos abatement.

- B. Field Test Reports: Fastener pull-out test report.
- C. Photographs or Video: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations.
 - 1. Submit before Work begins.
- D. Landfill Records: Indicate receipt and acceptance of **[demolished roofing materials and]** hazardous wastes, such as asbestos-containing materials, by a landfill facility licensed to accept them.

1.06 CLOSEOUT SUBMITTALS

- A. Certified statement from **<Insert name of manufacturer for existing warranted roof system>** stating that existing roof warranty has not been affected by Work performed under this Section.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: **[Approved by warrantor of existing roofing system to work on existing roofing] [and] [licensed to perform asbestos abatement in the state or jurisdiction where Project is located]**.
- B. Regulatory Requirements:
 - 1. Comply with governing EPA notification regulations before beginning roofing removal.
 - 2. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.08 FIELD CONDITIONS

- A. Existing Roofing System: **[Built-up asphalt] [Built-up coal-tar] [APP-modified bituminous] [SBS-modified bituminous] [EPDM] [CSPE] [KEE] [PVC] [TPO] [APP-modified bituminous protected membrane] [SBS-modified bituminous protected membrane] [Fluid-applied protected membrane] [Coated foamed] <Insert roof type>** roofing.
- B. General Considerations:
 - 1. Assess existing drain bowls for replacement. Replace drain bowl unless approved by Owner and assessed to have equal remaining useful life as newly installed roof.
 - 2. Assess roof drainage. Where roof drainage is insufficient, provide supplemental drainage during construction of new roof.
 - 3. Assess fall protection requirements.
 - 4. Assess existing base flashings.
 - a. Where existing roof base flashing is integrated into the wall and the wall weather barrier and this transition has a removable or cuttable metal counterflashing, the scope shall not include the removal of cladding.
 - b. Where existing roof base flashings are encapsulated behind cladding without a removable or cuttable metal counterflashing, the Contractor shall:
 - 1) Remove wall cladding and integrate roofing into existing weather resistant barrier and provide a metal counterflashing.

- 2) Where wall cladding removal is not feasible, an alternate scope and roof termination shall be provided to the Owner for approval.
5. Assess coping metal and other potentially salvable sheet metal items.
 - a. Confirm that salvable sheet metal will have an expected useful life that matches that of the new roof.
 - b. Confirm that salvable sheet metal will fit in the new roof.
- C. Owner **[will]** **[will not]** occupy portions of building immediately below reroofing area.
 1. Conduct reroofing so Owner's operations are not disrupted.
 2. Provide Owner with not less than **[72]** **<Insert number>** hours' written notice of activities that may affect Owner's operations.
 3. Coordinate work activities daily with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
 4. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below affected area.
 - a. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.
- D. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- E. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- F. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
 1. A roof moisture survey of existing roofing system is available for Contractor's reference.
 2. The results of an analysis of test cores from existing roofing system are available for Contractor's reference.
 3. Construction Drawings **[and Project Manual]** for existing roofing system are provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.
- G. Limit construction loads on existing roof areas to remain, and existing roof areas scheduled to be reroofed to **<Insert load>** for rooftop equipment wheel loads and **<Insert load>** for uniformly distributed loads.
- H. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
 1. Remove only as much roofing in one day as can be made watertight in the same day.
- I. Hazardous Materials:
 1. It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.

- a. Hazardous materials will be removed by Owner before start of the Work.
- b. Existing roof will be left no less watertight than before removal.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner.
 - a. Hazardous materials will be removed by Owner under a separate contract.
3. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - a. Hazardous material remediation is specified elsewhere in the Contract Documents.
 - b. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.
 - c. Coordinate reroofing preparation with hazardous material remediation to prevent water from entering existing roofing system or building.

1.09 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by <Insert name of manufacturer for existing warranted roof system>.
 1. Notify warrantor before proceeding with the Work.
 2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.
 - a. Submit documentation at Project closeout.

PART 2 PRODUCTS

2.01 TEMPORARY PROTECTION MATERIALS

- A. EPS Insulation: ASTM C578.
- B. Plywood: DOC PS 1, Grade CD, Exposure 1.
- C. OSB: DOC PS 2, Exposure 1.

2.02 TEMPORARY ROOFING MATERIALS

- A. Design and selection of materials for temporary roofing are Contractor's responsibilities.
- B. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft..
- C. Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.
- D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt-impregnated, glass-fiber felt.

- E. Asphalt Primer: ASTM D41/D41M.
- F. Roofing Asphalt: ASTM D312/D312M, Type III or IV.
- G. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approvals' RoofNav.

2.03 INFILL AND REPLACEMENT MATERIALS

- A. Use infill materials matching existing roofing system materials unless otherwise indicated.
 - 1. Infill materials are specified in [Section 07 52 16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"] [Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing"] unless otherwise indicated.
- B. Steel deck is specified in Section 05 31 00 "Steel Decking."
- C. Wood blocking, curbs, and nailers are specified in Section 06 10 00 "Rough Carpentry."
- D. Plywood roof sheathing is specified in Section 06 16 00 "Sheathing."
- E. Parapet Sheathing:
 - 1. ASTM C1177/C1177M or ASTM C1278/C1278M water-resistant gypsum substrate; **[1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]** thick.
 - 2. **[Pressure-preservative] [Exterior fire-retardant]**-treated plywood wall sheathing, **[19/32 inch] <Insert dimension>** thick, complying with Section 06 16 00 "Sheathing."
- F. Fasteners: Factory-coated steel fasteners with metal or plastic plates listed in FM Approvals' RoofNav, and acceptable to new roofing system manufacturer.

2.04 AUXILIARY REROOFING MATERIALS

- A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of **[existing and]**new roofing system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect existing roofing system that is not to be reroofed.
 - 2. Loosely lay 1-inch-minimum thick, EPS insulation over existing roofing in areas not to be reroofed.
 - a. Loosely lay 15/32-inch plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch.
 - 3. Limit traffic and material storage to areas of existing roofing that have been protected.
 - 4. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

5. Comply with requirements of existing roof system manufacturer's warranty requirements.
- B. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.
- C. Shut off rooftop utilities and service piping before beginning the Work.
- D. Test existing roof drains to verify that they are not blocked or restricted.
 1. Immediately notify Architect of any blockages or restrictions.
- E. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work.
 1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
- F. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- G. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.
 1. Prevent debris from entering or blocking roof drains and conductors.
 - a. Use roof-drain plugs specifically designed for this purpose.
 - b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
 2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.
 - a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.02 ROOF TEAR-OFF

- A. Full Roof Tear-off Considerations:
 1. Core existing roofs prior to tear off to:
 - a. Confirm substrate type and thickness
 - b. Confirm materials within roof
 - c. Confirm slope of substrate
 - d. Additional time/money shall not be provided to Contractor due to not confirming site conditions prior to tear off.
 2. Coordinate insulation height with existing base flashing counterflashing, doors, elevators and other surfaces.
 3. Confirm compatibility of new roofing against any remnants of the existing roofing. Remove these items or provide separation tapes/membranes.
- B. Notify Owner each day of extent of roof tear-off proposed for that day **[and obtain authorization to proceed]**.

- C. Lower removed roofing materials to ground and onto lower roof levels, using dust-tight chutes or other acceptable means of removing materials from roof areas.
- D. Remove aggregate ballast from roofing. [**Store aggregate ballast for reuse in manner not to exceed structural loading limitations of roof deck.**]
- E. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing using a power broom.
- F. Remove pavers and accessories from roofing.
 - 1. Store and protect pavers and accessories for reuse in manner not to exceed structural loading limitations of roof deck.
 - 2. Discard cracked pavers.
- G. Remove ballast, protection mat, and EPS insulation from protected roofing membrane.
 - 1. Discard EPS insulation that is damaged or exceeds [**8 lb/cu. ft.**] <Insert value>.
 - 2. Store EPS insulation for reuse and protect it from physical damage.
 - 3. Store ballast for reuse in manner not to exceed structural loading limitations of roof deck.
- H. Full Roof Tear-off: [**Where indicated on Drawings, remove**] [**Remove**] existing roofing and other roofing system components down to the existing [**roof deck**] [**concrete fill**].
 - 1. Remove [substrate board] [vapor retarder] [roof insulation] [and] [cover board].
 - 2. Remove base flashings and counter flashings.
 - 3. Remove perimeter edge flashing and gravel stops.
 - 4. Remove copings.
 - 5. Remove expansion-joint covers.
 - 6. Remove flashings at pipes, curbs, mechanical equipment, and other penetrations.
 - 7. Remove roof drains indicated on Drawings to be removed.
 - 8. Remove wood blocking, curbs, and nailers.
 - 9. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry.
 - a. Remove unadhered bitumen, unadhered felts, and wet felts.
 - 10. Remove excess asphalt from steel deck.
 - a. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
 - 11. Remove fasteners from deck [or cut fasteners off slightly above deck surface].
- I. Partial Roof Tear-off: [**Where indicated on Drawings, remove**] [**Remove**] existing roofing down to [**existing cover board**] [**existing insulation**] <Insert substrate> and immediately check for presence of moisture.
 - 1. [**Engage**] [**Owner will engage**] a qualified testing agency to perform the following test:
 - a. Coordinate with Owner's testing agency to schedule times for tests and inspections immediately after removal.

2. Survey exposed substrate that is to remain using infrared color thermography according to ASTM C1153.
 - a. Prepare survey report of initial scan indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.
3. Survey exposed substrate that is to remain using electrical capacitance/impedance testing according to ASTM D7954/D7954M.
 - a. Prepare survey report indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.
4. Survey exposed substrate that is to remain using nuclear hydrogen detection testing according to SPRI/RCI NT-1.
 - a. Prepare survey report indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.
5. Remove wet or damp materials below existing roofing and above deck as directed by Architect.
 - a. [Removal is paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.]
6. Inspect wood blocking, curbs, and nailers for deterioration and damage.
 - a. If wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.
 - b. [Removal is paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.]
7. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry.
 - a. Remove unadhered bitumen, unadhered felts, and wet felts.
8. Remove excess asphalt from steel deck that is exposed by removal of wet or damp materials.
 - a. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
9. Remove fasteners from deck [or cut fasteners off slightly above deck surface].

3.03 DECK PREPARATION

- A. Inspect deck after tear-off of roofing system.
- B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Architect.
 1. Do not proceed with installation until directed by Architect.
- C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Architect.
 1. Do not proceed with installation until directed by Architect.
- D. Provide additional deck securement as indicated on Drawings.

- E. Replace steel deck as indicated on Drawings.
- F. Replace steel deck as directed by Architect.
 - 1. Deck replacement will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
- G. Prepare and paint steel deck surface.
 - 1. Painting and preparation for painting is specified in Section 09 91 13 "Exterior Painting."
- H. Replace plywood roof sheathing as indicated on Drawings.
- I. Replace plywood roof sheathing as directed by Architect.
 - 1. Roof sheathing replacement will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.

3.04 INFILL MATERIALS INSTALLATION

- A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.
 - 1. Installation of infill materials is specified in Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing."
 - 2. Installation of wood blocking, curbs, and nailers is specified in Section 06 10 00 "Rough Carpentry."
- B. Install new roofing patch over roof infill area.
 - 1. If new roofing is installed the same day tear-off is made, roofing patch is not required.

3.05 TEMPORARY ROOFING

- A. Install approved temporary roofing over area to be reroofed.
- B. Install temporary roofing over area to be reroofed.
 - 1. [Install two glass-fiber felts] [Mechanically fasten base sheet and install a glass-fiber felt], lapping each sheet 19 inches over preceding sheet.
 - 2. Embed glass-fiber felt in a solid mopping of hot roofing asphalt applied within equiviscous temperature range.
 - 3. Glaze-coat completed surface with hot roofing asphalt.
- C. Remove temporary roofing before installing new roofing.
- D. Prepare temporary roof to receive new roofing [**according to approved temporary roofing proposal**] [**by patching and repairing temporary roofing**] <Insert preparation method>.
 - 1. Restore temporary roofing to watertight condition.
 - 2. Obtain approval for temporary roof substrate from roofing manufacturer and Architect before installing new roof.

3.06 ROOF RE-COVER PREPARATION

- A. Roof Re-Cover Considerations:
1. Interview facilities staff and provide roof assessment (top and underside) to determine if there are any current or past leaks.
 2. Contractor shall be required to provide non-destructive roof moisture scan to determine extent and location of any moisture in the existing roof assembly.
 - a. Core areas with suspected moisture to confirm what material within roof assembly is wet.
 - b. Replace wet materials as part of re-cover scope.
 3. Contractor shall be required to core roofs prior to tear off to:
 - a. Confirm substrate type and thickness.
 - b. Confirm materials within roof.
 - 1) If core outlines more than two layers of previously installed roofing, a re-cover roof is no longer a viable option unless AHJ approval is given in writing.
 - c. Confirm slope of substrate.
 - d. Core shall be taken at locations where roof moisture scan outlined potential moisture in existing roofing assembly.
 - e. Additional time/money shall not be provided to Contractor due to not confirming site conditions prior to tear off.
- B. Remove blisters, ridges, buckles, [**mechanically attached roofing fastener buttons projecting above roofing,**] and other substrate irregularities from existing roofing that inhibit new recover boards from conforming to substrate.
1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.
 2. Scarify surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards.
 3. Broom clean existing substrate.
 4. Coordinate with Owner's inspector to schedule times for tests and inspections.
 5. Verify that existing substrate is dry.
 - a. Spot check substrates with an electrical capacitance moisture-detection meter.
 6. Remove materials that are wet or damp.
 - a. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
- C. Remove blisters, ridges, buckles, [**mechanically attached roofing fastener buttons projecting above roofing,**] and other substrate irregularities from existing roofing that inhibit new [**recover boards**] [**roofing**] from conforming to substrate.
1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.

2. Shave surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new **[recover boards] [roofing]**.
 3. Broom clean existing substrate.
 4. Coordinate with Owner's inspector to schedule times for tests and inspections.
 5. Verify that existing substrate is dry before proceeding with installation.
 - a. Spot check substrates with an electrical capacitance moisture-detection meter.
 6. Remove materials that are wet and damp.
 - a. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
- D. Remove blisters and areas of roofing not fully adhered.
- E. Remove **[mechanically attached roofing fastener buttons projecting above roofing and other]** substrate irregularities that inhibit new recover boards from conforming to substrate.
1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.
 2. Clean substrate of contaminants, such as dirt, debris, oil, and grease, that can affect adhesion of coated foamed roofing.
 3. Power vacuum the existing roof surface.
 - a. If recommended by foam manufacturer, prime dried surface at recommended rate with recommended primer.
 4. Scarify surface of coated polyurethane roofing as necessary to achieve a suitable substrate for new roofing.
 5. Provide additional uplift securement for existing roofing system with new screws and plates applied to each roof zone at the following densities:
 - a. Field of roof, one fastener for each **<Insert area>**.
 - b. Corners of roof, one fastener for each **<Insert area>**.
 - c. Perimeters of roof, one fastener for each **<Insert area>**. Width of perimeter zone of roof is **<Insert dimension>**.
 6. Verify that surface is dry by pressing litmus paper to surface areas most likely to retain moisture, such as shaded areas and low spots.
 - a. If paper changes color, surface is too wet to apply foam.
- 3.07 BASE FLASHING REMOVAL
- A. Remove existing base flashings.
1. Clean substrates of contaminants, such as asphalt, sheet materials, dirt, and debris.
- B. Do not damage metal counterflashings that are to remain.
1. Replace metal counterflashings damaged during removal with counterflashings **[of same metal, weight or thickness, and finish as existing.] [specified in Section 07 62 00 "Sheet Metal Flashing and Trim."]** **[specified in Section 07 71 00 "Roof Specialties."]**

- C. Inspect parapet sheathing, wood blocking, curbs, and nailers for deterioration and damage.
 - 1. If parapet sheathing, wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.
- D. Remove existing parapet sheathing and replace with new parapet sheathing to comply with Section 06 16 00 "Sheathing."
 - 1. If parapet framing, wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.
- E. When directed by Architect, replace parapet framing, wood blocking, curbs, and nailers to comply with **[Section 05 40 00 "Cold-Formed Metal Framing.]" [Section 06 10 00 "Rough Carpentry."]**

3.08 FASTENER PULL-OUT TESTING

- A. **[Perform] [Retain independent testing and inspecting agency to conduct]** fastener pull-out tests according to SPRI FX-1, and submit test report to **[Architect] [and] [roofing manufacturer]** before installing new roofing system.
 - 1. Obtain **[Architect's] [roofing manufacturer's]** approval to proceed with specified fastening pattern.
 - a. **[Architect] [Roofing manufacturer]** may furnish revised fastening pattern commensurate with pull-out test results.

3.09 DISPOSAL

- A. Collect demolished materials and place in containers.
 - 1. Promptly dispose of demolished materials.
 - 2. Do not allow demolished materials to accumulate on-site.
 - 3. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION

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SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cold-applied, cut-back-asphalt dampproofing.
2. Cold-applied, emulsified-asphalt dampproofing.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.
2. Section 04 22 00 "Concrete Unit Masonry" for mortar parge coat on masonry surfaces.
3. Section [07 13 26 "Self-Adhering Sheet Waterproofing"] [Section 07 14 00 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"] [Section 07 14 16 "Cold Fluid-Applied Waterproofing"] for waterproofing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 FIELD CONDITIONS

- A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide **[protection course] [drainage panels] [and]** auxiliary materials recommended in writing by manufacturer of primary materials.

2.02 PERFORMANCE REQUIREMENTS

- A. VOC Content: Products are to comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.03 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

- A. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.
- B. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered [or nonfibered].

2.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Trowel Coats: ASTM D1227, Type II, Class 1.
- B. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.
- C. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

2.05 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Cut-Back-Asphalt Primer: ASTM D41/D41M.
- C. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- D. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.
- E. Patching Compound: **[Epoxy or latex-modified repair mortar] [Asbestos-free fibered mastic]** of type recommended in writing by dampproofing manufacturer.
- F. ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.
 - 1. Thickness: Nominal **[1/8 inch] [1/4 inch]**.
 - 2. Adhesive: Rubber-based solvent type recommended in writing by waterproofing manufacturer for protection course type.
- G. Fan folded, with a core of extruded-polystyrene board insulation faced on **[one side] [or both sides]** with plastic film, nominal thickness 1/4 inch, with a compressive strength of not less than 8 psi per ASTM D1621, and maximum water absorption by volume of 0.6 percent per ASTM C272/C272M.
- H. Extruded-polystyrene board insulation, unfaced, ASTM C578, Type X, 1/2 inch thick.
- I. Smooth-surfaced roll roofing complying with ASTM D6380/D6380M, Class S, Type III.

2.06 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel acceptable to dampproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core, with or without a polymeric film bonded to the other side; and with a vertical flow rate through the core of **[9 to 21 gpm per ft.] <Insert value>**.

2.07 INSULATION DRAINAGE PANELS

- A. Insulation Drainage Panels:
 - 1. Comply with Section 07 21 00 "Thermal Insulation" for insulation drainage panels.
 - 2. Unfaced or geotextile-faced, extruded-polystyrene board insulation according to ASTM C578, Type IV, 25-psi, or Type VI, 40-psi, minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.
- B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.
- B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.
- D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections [**; cover with asphalt-coated glass fabric**].

3.03 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
 - 1. Apply dampproofing to provide continuous plane of protection.
 - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
 - 1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

- C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
 - 1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
 - 2. Lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.
- D. Where dampproofing interior face of above-grade, exterior **[concrete] [and] [masonry] [single-wythe masonry]** walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.04 INSTALLATION OF COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

- A. Concrete Foundations and Parged Masonry Foundation Walls: Apply **[two brush or spray coats at not less than 1.25 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat] [or] [one trowel coat at not less than 4 gal./100 sq. ft.]**.
- B. Unparged Masonry Foundation Walls: Apply **[primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat] [or] [primer and one trowel coat at not less than 4 gal./100 sq. ft.]**.
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft..
- D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft..
- E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft..
- F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft..
- G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft..

3.05 INSTALLATION OF COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations and Parged Masonry Foundation Walls: Apply **[two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat] [one fibered brush or spray coat at not less than 3 gal./100 sq. ft.] [or] [one trowel coat at not less than 4 gal./100 sq. ft.]**.
- B. Unparged Masonry Foundation Walls: Apply **[primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat] [primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft.] [or] [primer and one trowel coat at not less than 5 gal./100 sq. ft.]**.
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft..
- D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft..

- E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft..
- F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft..
- G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft..
- H. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft..
- I. Interior Face of Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft..

3.06 INSTALLATION OF PROTECTION COURSE

- A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
 - 1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
 - 2. Install protection course **[on same day] [within 24 hours]** of dampproofing installation (while coating is tacky) to ensure adhesion.

3.07 INSTALLATION OF DRAINAGE PANEL

- A. Molded-Sheet Drainage Panels: Install panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. Install **[thermal insulation specified in Section 07 21 00 "Thermal Insulation,"] [protection course]** before installing drainage panels.
- B. Insulation Drainage Panels: Install panels over dampproofed surfaces. Use adhesive or another method that does not penetrate dampproofing. Cut and fit panels to within 3/4 inch of projections and penetrations.
 - 1. Ensure that drainage channels are aligned and free of obstructions.

3.08 PROTECTION

- A. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- B. Correct dampproofing that does not comply with requirements; repair substrates, and reapply dampproofing.

END OF SECTION

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SECTION 07 13 26

SELF-ADHERING SHEET WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Modified bituminous sheet waterproofing.
2. Protection course.
3. Molded-sheet drainage panels.
4. Insulation drainage panels.

B. Related Requirements:

1. Section 07 21 00 "Thermal Insulation."
2. Section 07 95 13.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
3. Section 07 95 13.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. Review transitions within waterproofing system and between waterproofing and adjacent air barrier.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written installation instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, air barrier, and other termination conditions.

1. Include setting drawings that indicate layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For each product, including the following materials:

1. 8-by-8-inch square of waterproofing and flashing sheet.
2. 4-by-4-inch square of drainage panel.
3. Plaza-deck paver, **[4-by-4-inch square] [full sized]**, in each color and texture required **[, including paver pedestal assembly]**.

1.04 INFORMATIONAL SUBMITTALS

- A. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC-ES AC380.
- B. Field quality-control reports.
- C. Qualification Statements: For Installer.
- D. Sample warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.06 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 1. Build mockups for each typical waterproofing installation including **[pavers and]** accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.
 - a. Size: **[100 sq. ft. in area] [As indicated on Drawings]**.
 - b. Description: Each type of **[wall] [deck] [and] [plaza] <Insert description>** installation.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to frozen, damp, or wet substrates.
 1. Do not apply waterproofing when snow, rain, fog, or mist is present.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.08 COORDINATION

- A. Coordinate Work under this Section with adjacent concrete foundation work, including fill **[, other waterproofing systems] [, under-slab vapor retarders] [, under-slab insulation] [and] [, subdrainage systems] [shoring]**.
- B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

1.09 WARRANTY

- A. Manufacturer's Warranty:
 - 1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 - a. Warranty Period: 5 years minimum for non-hydrostatic conditions and 10 years minimum watertight warranty for hydrostatic conditions from date of Substantial Completion.
 - 2. Termite Barrier Warranty: Manufacturer agrees to furnish replacement waterproofing termite barrier material and accessories for waterproofing termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
 - a. Warranty Period: Ten years from date of Substantial Completion.
- B. Installer's Special Warranty: Specified form, **[on warranty form at end of this Section,] signed** by Installer, covering Work of this Section, for warranty period of **[two] <Insert number>** years.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, **[and] [, including paver pedestal assembly]**.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements; see current Campus Standards for Preferred Manufacturers.

2.02 SOURCE LIMITATIONS

- A. Waterproofing System: Obtain waterproofing materials **[, protection course] [molded-sheet drainage panels] [insulation drainage panels]** from single source from single manufacturer.

2.03 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet Waterproofing: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement, and with release liner on adhesive side **[; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction]**.
 - 1. Physical Properties:

- a. Tensile Strength, Membrane: 250 psi minimum; ASTM D412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D1970/D1970M.
 - d. Puncture Resistance: 40 lbf minimum; ASTM E154/E154M.
 - e. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.
 - f. Water Vapor Permeance: 0.05 perm maximum; ASTM E96/E96M, Water Method.
 - g. Hydrostatic-Head Resistance: **[200 ft.] <Insert dimension>** minimum; ASTM D5385/D5385M.
2. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.
- B. Modified Bituminous Sheet Waterproofing, Foil Faced: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt integrally bonded to a 4-mil aluminum backing, and with release liner on adhesive side.
1. Physical Properties:
 - a. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D5147/D5147M.
 - b. Puncture Resistance: 40 lbf minimum; ASTM E154/E154M.
 - c. Water Vapor Permeance: 0.05 perm maximum; ASTM E96/E96M, Water Method.
 - d. Hydrostatic-Head Resistance: **[171 ft.] <Insert dimension>** minimum; ASTM D751.
 2. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.
- C. Modified Bituminous Sheet Waterproofing, Fabric Reinforced: Minimum 60-mil nominal thickness, self-adhering sheet consisting of rubberized-asphalt membrane with embedded fabric reinforcement, and with release liner on adhesive side.
1. Physical Properties:
 - a. Pliability: No cracks when bent 180 degrees over a 1-inch mandrel at minus 25 deg F; ASTM D146/D146M.
 - b. Puncture Resistance: **[40 lbf] [100 lbf]** minimum; ASTM E154/E154M.
 - c. Water Vapor Permeance: 0.05 perm maximum; ASTM E96/E96M, Water Method.
 2. Sheet Strips: Self-adhering, reinforced, rubberized-asphalt strips of same material and thickness as sheet waterproofing.
- D. Modified Bituminous Sheet Waterproofing/Termite Barrier: Minimum 68-mil nominal thickness, self-adhering sheet consisting of 64 mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement and with release liner on adhesive side **[/b> formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction].**
1. Physical Properties:

- a. Tensile Strength, Composite Membrane: 325 psi minimum; ASTM D412, Die C, modified.
 - b. Low-Temperature Flexibility: Pass at minus 25 deg F; ASTM D146/D146M.
 - c. Puncture Resistance: 50 lbf minimum; ASTM E154/E154M.
 - d. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.
 - e. Water Vapor Permeance: 0.05 perm maximum; ASTM E96/E96M, Method B.
 - f. Hydrostatic-Head Resistance: 231 ft. minimum; ASTM D5385/D5385M.
 - g. Resistance to Termite Penetration: Comply with ICC-ES AC380.
2. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.
- E. Modified Bituminous Deck-Paving Sheet Waterproofing: Minimum 65-mil nominal thickness, self-adhering sheets designed to be overlaid with asphalt paving; consisting of rubberized-asphalt membrane with woven or nonwoven fabric reinforcement laminated to one surface or embedded within the membrane, and with release liner on adhesive side.
1. Physical Properties:
 - a. Tensile Strength, Membrane: **[50 lbf/in.] <Insert value>** minimum; ASTM D882.
 - b. Pliability: Unaffected when bent 180 degrees over a 1/4-inch mandrel at minus 15 deg F; ASTM D146/D146M.
 - c. Puncture Resistance: **[40 lbf] [100 lbf] [200 lbf]** minimum; ASTM E154/E154M.
 2. Sheet Strips: Self-adhering, reinforced, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.04 ACCESSORIES FOR WATERPROOFING

- A. Furnish accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatibility with sheet waterproofing.
 1. Furnish liquid-type accessory materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid **[waterborne] [solvent-borne]** primer as recommended in writing for substrate by sheet waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner as recommended in writing for substrate by sheet waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum or stainless steel bars, approximately 1 by 1/8 inch, predrilled at 9-inch centers.

2.05 PROTECTION COURSE

- A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
1. Thickness: Nominal **[1/8 inch] [1/4 inch] [1/8 inch]** for vertical applications; **1/4 inch** elsewhere].
 2. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for protection course type.
- B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on **[one side] [or] [both sides]** with plastic film, nominal thickness 1/4 inch, with compressive strength of not less than 8 psi when tested in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.
- C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch thick.
- D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. minimum density, 1-inch minimum thickness.

2.06 MOLDED-SHEET DRAINAGE PANELS

- A. Molded-Sheet Drainage Panel with Polymeric Film, Nonwoven-Geotextile Faced: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of **[9 to 21 gpm per ft.] <Insert values>**.
- B. Molded-Sheet Drainage Panel without Polymeric Film, Nonwoven-Geotextile Faced: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of **[9 to 21 gpm per ft.] <Insert values>**.
- C. Molded-Sheet Drainage Panel with Polymeric Film, Woven-Geotextile Faced: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than **[2.8 gpm per ft.] <Insert value>**.
- D. Molded-Sheet Drainage Panel without Polymeric Film, Woven-Geotextile Faced: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 sieve, laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than **[2.8 gpm per ft.] <Insert value>**.

- E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of **[9 to 17 gpm per ft.] <Insert values>** and a minimum horizontal, in-plane flow rate **[as indicated on Drawings] <Insert requirement>**. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.
- F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 sieve; and with a vertical flow rate through the core of **[21 to 97 gpm per ft.] <Insert values>** and a minimum horizontal, in-plane flow rate **[as indicated on Drawings] [of 21 gpm per ft.] <Insert requirement>**. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

2.07 INSULATION DRAINAGE PANELS

- A. Insulation Drainage Panels, Unfaced, Type IV: ASTM C578, Type IV, 25 psi minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- B. Insulation Drainage Panels, Geotextile Faced, Type IV: ASTM C578, Type IV, 25 psi minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
- C. Insulation Drainage Panels, Unfaced, Type VI: ASTM C578, Type VI, 40 psi minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- D. Insulation Drainage Panels, Geotextile Faced, Type VI: ASTM C578, Type VI, 40 psi minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
- E. Insulation Drainage Panels, Unfaced, Plaza-Deck Type VI: ASTM C578, Type VI, 40 psi minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.
- F. Insulation Drainage Panels, Geotextile Faced, Plaza-Deck Type VI: ASTM C578, Type VI, 40 psi minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.
- G. Insulation Drainage Panels, Unfaced, Plaza-Deck Type VII: ASTM C578, Type VII, 60 psi minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

- H. Insulation Drainage Panels, Geotextile Faced, Plaza-Deck Type VII: ASTM C578, Type VII, 60 psi minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.
 - 1. Verify that concrete has cured and aged for minimum time recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean, prepare, and treat substrates in accordance with manufacturer's written installation instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections.
- E. Fill form tie holes, honeycomb, aggregate pockets, holes, and other voids.
- F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.
 - 1. Install sheet strips of width in accordance with manufacturer's written installation instructions and center over treated construction and contraction joints and cracks exceeding a width of **[1/16 inch] [or] [1/8 inch for modified bituminous deck-paving waterproofing]**.
- G. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths in accordance with manufacturer's written installation instructions.
 - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- H. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's written installation instructions.
 - 1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:

- a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
 - b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
- I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.03 INSTALLATION OF MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Install modified bituminous sheets in accordance with waterproofing manufacturer's written installation instructions.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.
- D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.
- E. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.
- F. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- G. Seal edges of sheet waterproofing terminations with **[mastic] [termination bar and sealant]**.
- H. Install sheet waterproofing and accessory materials to tie into adjacent waterproofing.
- I. Roll waterproofing membrane to firmly adhere to substrate. Roll seams and terminations.
- J. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.
- K. Immediately install protection course with butted joints over waterproofing membrane.
 1. **[Molded-sheet drainage panels] [Insulation drainage panels]** may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.04 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written installation instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install **[board insulation] [protection course]** before installing drainage panels.

3.05 INSTALLATION OF INSULATION DRAINAGE PANELS

- A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.
- B. Ensure that drainage channels are aligned vertically and free of obstructions.
- C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied in accordance with manufacturer's written installation instructions.
- D. On horizontal surfaces, loosely lay insulation drainage panels in accordance with manufacturer's written installation instructions. Stagger end joints and tightly abut insulation units.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a **[full-time] site** representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.
- C. Waterproofing will be considered defective if it does not pass tests and inspections.

3.07 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

SECTION 07 13 54

THERMOPLASTIC SHEET WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Below grade walls / slabs waterproofing.
1. PVC sheet waterproofing.
 2. CTEM sheet waterproofing.
 3. Drainage panels.
- B. Related Requirements:
1. Section 07 21 00 "Thermal Insulation" for general building insulation.
 2. Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing" for thermoplastic membranes used **[for roofing] [and] [beneath vegetated roof assemblies]**.
 3. Section 07 95 13 "Seismic Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
1. Include layout drawings showing locations of submembrane containment strips **[and control test drains]**.
 2. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
- C. Samples: For each exposed product and for each color and texture specified, including the following products:
1. 8-by-8-inch square of waterproofing and flashing sheet.

2. 4-by-4-inch square of drainage panel.
3. Plaza-deck paver, **[4-by-4-inch square] [full sized]**, in each color and texture required.
4. Paver pedestal assembly.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 1. Build for each typical waterproofing installation including **[pavers and]** accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.
 - a. Size: **[100 sq. ft. in area] [As indicated on Drawings]**.
 - b. Description: Each type of **[deck] [and] [plaza] <Insert description>** installation.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Do not permit asphaltic materials or polystyrene insulation to contact PVC materials.
- C. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.07 WARRANTY

- A. Manufacturer's Warranty: [Manufacturer agrees to furnish replacement waterproofing material for] [Manufacturer and Installer agree to repair or replace] waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 1. Warranty Period: **[Five] [10] [20] <Insert number>** years from date of Substantial Completion.

- B. Installer's Special Warranty: Specified form, **[on warranty form at end of this Section,]**signed by Installer, covering Work of this Section, for warranty period of **[two]** **<Insert number>** years.
1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials **[, protection course,] [and] [drainage panels]** from single source from single manufacturer.

2.02 PVC SHEET WATERPROOFING

- A. PVC Sheet: **[60-mil-] [80-mil-]** thick, PVC membrane with integral pigments, stabilizers, UV absorbers, biocide, and nonwoven fiberglass reinforcement; with the following properties measured according to standard test methods referenced:
1. Tensile Strength: 1500 psi minimum; ASTM D638.
 2. Elongation at Break: 240 percent minimum, machine direction; ASTM D638.
 3. Seam Strength: 90 percent minimum of tensile strength; ASTM D638.
 4. Retention of Properties after Heat Aging: 95 percent minimum retention of tensile strength and elongation; ASTM D638 after 168 hours at 194 deg F; ASTM D3045.
 5. Tear Resistance: 21 lbf minimum; ASTM D1004.
 6. Low-Temperature Bend: Pass at minus 40 deg F; ASTM D2136.
 7. Linear Dimension Change: 0.002 percent maximum after 6 hours at 176 deg F; ASTM D1204.
 8. Water Absorption: 2.5 percent maximum weight gain after 168 hours' immersion at 158 deg F; ASTM D570.
 9. Dynamic Puncture Resistance: 117.7 ft. pdl minimum; ASTM D5635/D5635M.
- B. Self-Adhered PVC Sheet: 120-mil-thick, composite sheet composed of 60-mil-thick, PVC membrane with integral pigments, stabilizers, biocide, and nonwoven fiberglass reinforcement; a 60-mil-thick, nonpermeable, closed-cell-foam backing layer; and a pressure-sensitive adhesive coating; with the following properties measured according to standard test methods referenced:
1. Tensile Strength: 1500 psi minimum; ASTM D638.
 2. Elongation at Break: 240 percent minimum, machine direction; ASTM D638.
 3. Seam Strength: 90 percent minimum of tensile strength; ASTM D638.
 4. Retention of Properties after Heat Aging: 95 percent minimum retention of tensile strength and elongation; ASTM D638 after 168 hours at 194 deg F; ASTM D3045.
 5. Tear Resistance: 21 lbf minimum; ASTM D1004.
 6. Linear Dimension Change: 0.002 percent maximum after 6 hours at 176 deg F; ASTM D1204.

7. Dynamic Puncture Resistance: 949.2 ft. pdl minimum; ASTM D5635/D5635M.

2.03 CTEM SHEET WATERPROOFING

- A. CTEM Sheet: **[60-mil-] [75-mil-]**, coal tar elastomeric (CTEM) membrane with coal tar pitch, PVC, and kee resin; with the following properties measured in accordance with standard test methods referenced:
 1. Tensile Strength: 1050 psi minimum, ASTM D638.
 2. Elongation at Break: 150 percent minimum, machine direction; ASTM D638.
 3. Seam Strength: 95 percent minimum of tensile strength; ASTM D638.
 4. Retention of Properties after Heat Aging: ASTM D3045.
 5. Tear Resistance: 250 lb/in. minimum, ASTM D1004.
 6. Low Temperature Bend, Minus 40 Deg F (Minus 40 Deg C): Pass, ASTM D2136.
 7. Water Vapor Permeance: 0.375 perm maximum, ASTM E96/E96M.
 8. Hydrostatic Pressure Resistance: 290 psi minimum, ASTM D751.
- B. Self-Adhered CTEM Sheet: Composite sheet composed of **[60-mil-] [75-mil-]** thick, coal tar elastomeric (CTEM) membrane with coal tar pitch, PVC, and kee resin; and a pressure-sensitive adhesive coating; with the following properties measured in accordance with standard test methods referenced:
 1. Tensile Strength: 1050 psi minimum, ASTM D638.
 2. Elongation at Break: 150 percent minimum, machine direction; ASTM D638.
 3. Seam Strength: 95 percent minimum of tensile strength; ASTM D638.
 4. Retention of Properties after Heat Aging: ASTM D3045.
 5. Tear Resistance: 250 lb/in. minimum, ASTM D1004.
 6. Low Temperature Bend, Minus 40 Deg F (Minus 40 Deg C): Pass, ASTM D2136.
 7. Water Vapor Permeance: 0.375 perm maximum, ASTM E96/E96M.
 8. Hydrostatic Pressure Resistance: 290 psi minimum, ASTM D751.
- C. Fleece-Backed CTEM Sheet: Composite sheet composed of 60-mil-thick, coal tar elastomeric (CTEM) membrane with coal tar pitch, PVC, and kee resin with a 30-40-mil-thick polyester fleece backing; with the following properties measured in accordance with standard test methods referenced:
 1. Tensile Strength: 1300 psi minimum, ASTM D638.
 2. Elongation at Break: 150 percent minimum, machine direction; ASTM D638.
 3. Seam Strength: 95 percent minimum of tensile strength; ASTM D638.
 4. Retention of Properties after Heat Aging: ASTM D3045.
 5. Tear Resistance: 380 lb/in. minimum, ASTM D1004.
 6. Low Temperature Bend, Minus 40 Deg F (Minus 40 Deg C): Pass, ASTM D2136.
 7. Water Vapor Permeance: 0.375 perm maximum, ASTM E96/E96M.
 8. Hydrostatic Pressure Resistance: 290 psi minimum, ASTM D751.

2.04 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
 - B. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing.
 - C. Exposed PVC Sheet Flashing: PVC-sheet flashing **[60 mils] [80 mils] [96 mils]** thick; PVC with integral pigments, stabilizers, UV absorbers, and biocide; reinforced with nonwoven fiberglass.
 - D. Exposed CTEM Sheet Flashing: CTEM-sheet flashing 60-mil-thick; modified coal tar elastomeric sheet.
 - 1. Sheet Width: **[4 inches] [6 inches] [9 inches] [12 inches]** [or] [as required].
 - E. Preformed Flashing Shapes: As needed to suit Project requirements including, but not limited to, detail corners, level changes, stop ends, and other similar special applications
 - F. Surface Conditioner: Manufacturer's standard waterborne surface treatment to bind residual surface dust and efflorescence to substrate.
 - G. Bonding Adhesives: For bonding waterproofing sheets **[, containment strips,]** and sheet flashings to substrates.
 - H. Containment Strip: Manufacturer's standard asphalt-resistant, 60-mil-thick, **[PVC] [CTEM]** strip; reinforced with nonwoven fiberglass; 12 inches wide.
 - I. Geotextile Leveling Layer: Manufacturer's standard 0.22-inch-thick, nonwoven polypropylene fabric.
 - J. Separation Layer: Manufacturer's standard 0.16-inch-thick, nonwoven polypropylene fabric.
 - K. Protection Course: **[39-mil-thick, HDPE sheet]** [or] **[51-mil-thick, hot-air-weldable, PVC sheet]** protection layer.
 - L. Waterproofing and Sheet-Flashing Accessories: Sealants, pourable sealers, termination reglets, clamps, compression bars, tapes, preformed cone and stack flashings, and other accessories recommended by waterproofing manufacturer for intended use.
 - M. Control Test Drain: Manufacturer's standard assembly to verify the absence or presence of leaks from underside of waterproofed slab.
 - N. Metal Termination Bars: Manufacturer's standard stainless steel or aluminum bars, prepunched, with noncorrosive fasteners.
- 2.05 DRAINAGE PANELS
- A. Composite Drainage Panels: Drainage panel acceptable to waterproofing manufacturer and consisting of a nonbiodegradable core of fused, entangled filaments or a three-dimensional

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.
- F. Prepare, treat, and seal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.03 INSTALLATION OF FULLY ADHERED SHEET WATERPROOFING

- A. Install self-adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions.
 - 1. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
 - 2. Install laps shingled with slope of deck where possible.
 - 3. Install flashings concurrently with deck sheet.
 - 4. Perform hot-air welding to ensure a watertight seam installation. Inspect outside edge of seams with pointed metal probe and ensure completed laps lay flat and are free of voids, fishmouths, or wrinkles.
 - 5. Install temporary cut-offs if work is interrupted. Remove the cut-offs completely before proceeding with the installation.
 - 6. Install sheets and auxiliary materials to tie into adjoining waterproofing.
- B. Apply surface conditioner, at required rate, to substrates to receive waterproofing. Apply only at temperatures greater than 25 deg F and rising.
- C. Apply and firmly adhere sheets to substrate; butt adjoining sheets tightly. Apply only when the membrane, air, and substrate temperatures are greater than 40 deg F and rising. Apply a minimum 8-inch-wide cover strip centered over joints and lap edges; hot-air weld cover strip to deck sheet.

- D. Hot-air weld three-way overlaps or T-joints with a 4-inch-round or square patch.
- E. Unless terminations and deck-sheet waterproofing perimeter are sealed with flashings, secure them with mechanically anchored metal termination bar. Seal edge of termination with sealant.
- F. Install flashing at deck drains. Spread sealant bed over deck drain flange, lap flashing membrane into drain flange and over deck sheet according to membrane manufacturer's written instructions, and hot-air-weld flashing to deck sheet; securely seal flashing sheet in place with clamping ring.
- G. Perform field quality-control testing before subsequent work.
- H. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

3.04 INSTALLATION OF LOOSELY LAID SHEET WATERPROOFING

- A. Install loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.
 - 1. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
 - 2. Install laps shingled with slope of deck where possible.
 - 3. Install flashings concurrently with deck sheet.
 - 4. Perform hot-air welding to ensure a watertight seam installation. Inspect outside edge of seams with pointed metal probe and ensure completed laps lay flat and are free of voids, fishmouths, or wrinkles.
 - 5. Install temporary cut-offs if work is interrupted. Remove the cut-offs completely before proceeding with the installation.
 - 6. Install sheets and auxiliary materials to tie into adjoining waterproofing.
- B. Install geotextile leveling layer over entire area to receive deck sheet. Lap edges at least 4 inches and spot adhere fabric to deck as required to keep in position as waterproofing sheet is placed in position. Trim fabric using scissors or utility blades; do not use welding equipment to cut fabric.
- C. Apply deck sheet over area, lapping edges at least 3 inches for machine welding or at least 4 inches for hand welding. Hot-air weld sheets.
- D. Hot-air weld three-way overlaps or T-joints with a 4-inch-round or square patch.
- E. Secure perimeter of deck sheet with manufacturer's standard metal termination bars and accessories as recommended by manufacturer for each condition.
- F. At deck drains, spread sealant bed over drain flange and lap membrane into drain flange according to membrane manufacturer's written instructions; securely seal sheets in place with clamping ring.
- G. Perform field quality-control testing before subsequent work.

- H. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

3.05 INSTALLATION OF COMPARTMENTED, LOOSELY LAID SHEET WATERPROOFING

- A. Install compartmented, loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.
 1. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
 2. Install laps shingled with slope of deck where possible.
 3. Install flashings concurrently with deck sheet.
 4. Perform hot-air welding to ensure a watertight seam installation. Inspect outside edge of seams with pointed metal probe and ensure completed laps lay flat and are free of voids, fishmouths, or wrinkles.
 5. Install temporary cut-offs if work is interrupted. Remove the cut-offs completely before proceeding with the installation.
 6. Install sheets and auxiliary materials to tie into adjoining waterproofing.
- B. Construct a test containment grid before beginning installation. Perform manufacturer's recommended peel test on the test containment grid and on each day's completed waterproofing work before resuming the following day's installation.
- C. Install submembrane containment grid to form compartments secured by containment strips. Also, install containment strips at the base of walls, curbs, penetrations, terminations, and transitions and at the perimeter of the installation. Secure containment grid to substrate with bonding adhesive.
- D. Install geotextile leveling layer over entire area between containment strips. Lap edges at least 4 inches and spot adhere fabric to deck as required to keep in position as waterproofing sheet is placed in position. Trim fabric even with edges of containment strips using scissors or utility blades; do not use welding equipment to cut fabric.
- E. Control-Test-Drain Installation: Drill 1-inch-diameter hole through the substrate at or near the low point of each compartment and install control test drain, according to manufacturer's written instructions, so as to enable verification of the absence or presence of leaks from underside of waterproofed slab.
- F. Apply deck sheet over area, lapping edges at least 3 inches for machine welding or at least 4 inches for hand welding. Hot-air weld the sheet to containment strips.
- G. Hot-air weld three-way overlaps or T-joints with a 4-inch-round or square patch.
- H. Install flashing at deck drains. Spread sealant bed over deck drain flange, lap flashing membrane into drain flange and over containment strips according to membrane manufacturer's written instructions, and hot-air weld flashing to containment strips; securely seal flashing sheet in place with clamping ring.
- I. Perform field quality-control testing before subsequent work.

- J. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

3.06 INSTALLATION OF SHEET FLASHING

- A. Form wall flashings exposed in final construction using exposed sheet flashing; otherwise, use concealed sheet flashing.
- B. Lap sheet flashings over deck sheet or containment strips. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- C. Extend flashings a minimum of 8 inches above the overburden unless otherwise indicated on Drawings and acceptable to waterproofing manufacturer.
- D. Hot-air weld joints with deck sheet or containment strips and end laps of overlapping sheet flashings and accessories to ensure a watertight seam installation.
- E. Hot-air weld three-way overlaps or T-joints with a 4-inch-round or square patch.
- F. Secure flashings along top edge with mechanically anchored metal termination bar or with mechanically anchored metal reglet for subsequent metal counterflashing. Seal top of termination with sealant.
- G. Terminate deck sheet at expansion joints and discontinuous deck-to-wall or deck-to-deck joints. Bridge and cover joints with sheet flashing and joint accessories according to manufacturer's written instructions for each type of joint.

3.07 INSTALLATION OF PROTECTION COURSE

- A. Install separation layer over sheet waterproofing before placing protection course.
- B. Install protection course over **[sheet waterproofing]** **[separation layer]** according to manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.

3.08 INSTALLATION OF DRAINAGE PANELS

- A. Install drainage panels immediately after waterproofing-membrane manufacturer's inspection and acceptance of the waterproofing installation.
- B. Place and secure drainage panels directly over the waterproofing membrane, according to waterproofing manufacturer's written instructions.
- C. Trim drainage panels to fit closely around penetrations and at the base of drains to ensure that water flows freely from composite into drain openings.
- D. Cover cut edges of drainage panels to protect waterproofing membrane from damage.
- E. Protect installed drainage panels during subsequent construction.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests.

- B. Manufacturer's Field Service: Engage a **[full-time]** site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.
 - C. Flood Testing: Flood test each deck area for leaks, in accordance with procedures in ASTM D5957, after completing waterproofing but before placing overlying construction. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - 1. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and a maximum depth of 4 inches. Maintain 2 inches of clearance from top of sheet flashings.
 - 2. Flood each area for **[24] [48] [72]** hours.
 - 3. Testing agency is to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.
 - 4. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
 - D. Electronic Leak-Detection Testing:
 - 1. Testing agency is to test **[each deck area] [each deck area indicated for testing on Drawings]** <Insert area to be tested> for leaks using an electronic leak-detection method that locates discontinuities in the waterproofing membrane.
 - 2. Testing agency is to perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.
 - 3. Testing agency is to create a conductive electronic field over the area of waterproofing to be tested and electronically determine locations of discontinuities or leaks, if any, in the waterproofing.
 - 4. Testing agency is to provide survey report indicating locations of discontinuities, if any.
 - E. Waterproofing will be considered defective if it does not pass tests and inspections.
 - F. Prepare test and inspection report.
- 3.10 PROTECTION, REPAIR, AND CLEANING
- A. Do not permit foot or vehicular traffic on unprotected membrane.
 - B. Protect waterproofing from damage and wear during remainder of construction period.
 - C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
 - D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

SECTION 07 14 13

HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hot fluid-applied, rubberized-asphalt waterproofing membrane.
2. Molded-sheet drainage panels.
3. Insulation.
4. Plaza-deck pavers.

B. Related Requirements:

1. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
2. Section 07 55 56 "Fluid-Applied Protected Membrane Roofing" for hot fluid-applied, rubberized-asphalt roofing.
3. Section 07 91 00 "Preformed Joint Seals" for foundation-wall expansion joints that interface with waterproofing.
4. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Section 07 95 13.19 "Parking Deck Expansion Joint Cover Assemblies" for plaza expansion-joint assemblies that interface with waterproofing.
6. Section 32 14 00 "Unit Paving" for plaza-deck pavers set on setting beds.

1.02 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review waterproofing requirements, including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. If needed, insert list of conference participants not mentioned in Section 01 31 00 "Project Management and Coordination."

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For plaza-deck pavers [, **full sized**] in each color and texture required.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[Installer] [and] [testing agency]**.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Install waterproofing to **[100 sq. ft.] <Insert value>** of **[deck] [wall]** to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality. **[Install pavers and paver supports to demonstrate aesthetic effects, and set quality standards for materials and execution.]**

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Protect stored materials from direct sunlight.

1.07 FIELD CONDITIONS

A. Weather Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below zero deg F.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.08 WARRANTY

- A. When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws. Example in "Special Warranty" Paragraph below is a labor-and-material warranty. Verify coverage with manufacturers. Manufacturers' warranties customarily do not include costs of excavating and exposing the waterproofing membrane as well as backfilling and restoring affected construction in vertical applications.
- B. Special Warranty: Manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.
1. In addition to special warranty covering waterproofing and sheet flashings above, some manufacturers offer total-system warranties for plaza decks that include insulation and pavers. These warranties may include the costs of removing and reinstalling readily removable construction overlaying waterproofing. Verify coverage with manufacturers.
 2. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.
 3. Warranty insulation retains 90 percent of original published thermal value.
 4. Warranty pavers do not dish or warp and do not crack, split, or disintegrate in freeze-thaw conditions.
 5. Verify available warranties and warranty periods. Fabric-reinforced, hot fluid-applied waterproofing may qualify for 10-year warranties from some manufacturers.
 6. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Installer's Warranty: Specified form **[, on warranty form at end of this Section,]** signed by Installer, covering Work of this Section, for warranty period of **[two] <Insert number>** years.
1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements:
1. American Hydrotech.
 2. Monolithic Membrane 6125 CETCO.
 3. Strataseal HR Carlisle Coating & Waterproofing.
 4. CCW 500-R Tremco, TREMproof 6100.
 5. Or Approved Equivalent.

2.02 SOURCE LIMITATIONS

- A. Source Limitations: Obtain waterproofing materials **[sheet flashings] [protection course] [molded-sheet drainage panels] [insulation] [pavers] [and] [pedestals]** from single source from single manufacturer.

2.03 WATERPROOFING MEMBRANE

- A. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.

2.04 HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

- A. Single-Component Waterproofing: **[Reinforced] [Unreinforced]**; 100 percent solids rubberized asphalt membrane.
 - 1. Flow: 1/8 inch maximum at 140 deg F in accordance with ASTM D5329.
 - 2. Flash Point: Not less than 500 deg F and not less than 77 deg F above the manufacturer's maximum recommended application temperature in accordance with ASTM D92.
 - 3. Water-Vapor Permeance: 0.027 perm in accordance with ASTM E96/E96M, Procedure E.
 - 4. Crack Bridging Capability: No cracking, splitting, or loss of adhesion in accordance with ASTM C1305/C1305M.

2.05 ACCESSORIES

- A. General: Accessory materials recommended by waterproofing manufacturer for intended use and compatible with waterproofing.
- B. Primer: ASTM D41/D41M, asphaltic primer.
- C. Elastomeric Sheet: 50-mil-minimum, uncured sheet neoprene **[with manufacturer's recommended contact adhesives]** as follows:
 - 1. Tensile Strength: 1400 psi minimum; ASTM D412, Die C.
 - 2. Elongation: 300 percent minimum; ASTM D412.
 - 3. Tear Resistance: 125 psi minimum; ASTM D624, Die C.
 - 4. Brittleness: Does not break at minus 30 deg F; ASTM D2137.
- D. Liquid Applied Flashing Membrane: Two-component, PMMA liquid applied resin membrane flashing system.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel, or aluminum termination bars; approximately 1 by 1/8 inch thick; with stainless steel anchors.
- F. Sealants and Accessories: Manufacturer's recommended sealants and accessories.
- G. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
- H. Asphaltic Protection Course: ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
 - 1. Thickness: **[1/8 inch, nominal] [1/4 inch, nominal] [1/8 inch, nominal, for vertical applications; 1/4 inch, nominal, elsewhere].**
- I. Rubberized Sheet Protection Course: Manufacturer's standard, 80- to 90-mil-thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.

2.06 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve, laminated to one side **[with] [or] [without]** a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm/ft..
- B. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 sieve, laminated to one side **[with] [or] [without]** a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm/ft..

2.07 INSULATION

- A. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C578, **[Type IV, 25 psi] [Type VI, 40 psi] [Type VII, 60 psi] [Type V, 100 psi]** minimum compressive resistance, **[square] [or] [shiplap]** edged.
- B. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C578, **[Type IV, 25 psi] [or] [Type VI, 40 psi]** minimum compressive resistance; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- C. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C578, **[Type IV, 25 psi] [or] [Type VI, 40 psi]** minimum compressive resistance; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.
- D. Unfaced Plaza-Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C578, **[Type VI, 40 psi] [Type VII, 60 psi]** minimum compressive resistance; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
- E. Geotextile-Faced Plaza-Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C578, Type VII, 60 psi minimum compressive resistance; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.

2.08 PLAZA-DECK PAVERS

- A. Plaza-Deck Pavers: **[Brick] [Concrete] [Asphalt-block] [Granite] [Limestone] [Marble] [Quartz-based stone] [Slate] [Travertine]** pavers specified in Section 32 14 00 "Unit Paving."
- B. Concrete Plaza-Deck Pavers: Heavyweight, hydraulically pressed, concrete units, **[square edged] [with top edges beveled 3/16 inch]**, manufactured for use as plaza-deck pavers; minimum compressive strength **[7500 psi] [6500 psi] <Insert value>**, ASTM C140; absorption not greater than 5 percent, ASTM C140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance in accordance with ASTM C67.
 1. Thickness: **[1-5/8 inches] [1-3/4 inches] [2 inches] [2-3/8 inches]** <Insert dimension>.
 2. Face Size: **[8-7/8 inches square] [9 inches square] [9 by 18 inches] [12 inches square] [12 by 24 inches] [18 inches square] [24 inches square] [As indicated]** <Insert dimensions and shape>.

3. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- C. Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including **[fixed-height] [adjustable or stackable]** pedestals, shims, and spacer tabs for joint spacing of **[1/8 inch] [3/16 inch] [1/8 to 3/16 inch]**.
 1. Concrete Fill: ACI 301, compressive strength of 5000 psi at 28 days, and air content of 6 percent.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
 3. Verify adhesion of membrane meets Manufacturer's requirements prior to installation.
 4. Verify slope of substrate. Where slope does not meet intent of construction documents, provide Manufacturer approved cementitious topping to create slope and wait required cure period before membrane application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- C. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
- D. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- E. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- F. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
 - 1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.
- G. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, and other voids.

3.03 JOINTS, CRACKS, AND TERMINATIONS

- H. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
 - 1. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt in accordance with ASTM D4258.
 - 2. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
 - 3. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches on each side of nonmoving joints and cracks not exceeding 1/8 inch thick, and beyond roof drains and penetrations.
 - a. Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.
- I. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.04 INSTALLATION OF LIQUID FLASHING

- J. All detailing and flashing shall be done in accordance with the manufacturer's standard guideline details.
- K. All detailing and flashing shall be completed before installing the membrane over the field of the substrate.
- L. All liquid-applied, resin flashings shall be applied over properly completed membrane flashing details in accordance with the manufacturer's standard guideline details.

3.05 INSTALLATION OF FLASHING

- M. Install elastomeric sheets at terminations of waterproofing membrane according to manufacturer's written instructions.
- N. Prime substrate with asphalt primer.
- O. Install elastomeric sheet and adhere to deck and wall substrates in a layer of hot rubberized asphalt.
- P. Extend elastomeric sheet up walls or parapets a minimum of 8 inches above plaza-deck pavers and 6 inches onto deck to be waterproofed.
- Q. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of waterproofing.

3.06 INSTALLATION OF HOT FLUID-APPLIED, RUBBERIZED ASPHALT WATERPROOFING MEMBRANE

- R. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow it to dry.
- S. Heat and apply rubberized asphalt according to manufacturer's written instructions.
 - 1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.
- T. Start application with manufacturer's authorized representative present.
- U. Unreinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, 180-mil minimum thickness.
- V. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils; embed reinforcing fabric, overlapping sheets 2 inches; spread another 125-mil-thick layer to provide a uniform, reinforced, seamless membrane 215 mils thick.
- W. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.
- X. Cover waterproofing with protection course with overlapped joints before membrane is subject to **[backfilling] [construction or vehicular traffic]**.

3.07 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- Y. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install **[board insulation] [protection course]** before installing drainage panels.

3.08 INSTALLATION OF INSULATION

- Z. Install **[one or more layers of board insulation to achieve required thickness] [and] [insulation drainage panels]** over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.
- AA. On vertical surfaces, set insulation units into rubberized asphalt according to manufacturer's written instructions.
- BB. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.09 INSTALLATION OF PLAZA-DECK PAVERS

- CC. Install concrete pavers according to manufacturer's written instructions.
- DD. Accurately install **[fixed] [adjustable]**-height paver pedestals and accessories to elevations required. Adjust for final level and slope with shims.
 - 1. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure in accordance with ACI 301.
- EE. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
 - 1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
- FF. Install pavers to not vary more than 1/16 inch in elevation between adjacent pavers or more than 1/16 inch from surface plane elevation of individual paver.
- GG. Limit variation in paving installation to within **[1/4 inch in 10 feet] <Insert dimensions>** of surface plane in any direction; noncumulative.

3.10 FIELD QUALITY CONTROL

- HH. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of membrane, flashings, protection, and drainage components; furnish daily reports to Architect.
 - 1. Site representative is to measure membrane thickness with pin tester or other suitable device at least once for every 100 sq. ft. and include measurements in reports.
- II. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.
 - 1. The roof area or portions thereof shall be leak tested by means of Electronic Leak Detection (ELD) or by ponding water at a minimum depth of 2" (50.8 mm) for a period of 48 hours to check the integrity of the membrane installation.
 - a. ELD testing should be performed on all installed membrane assembly. Testing is to be performed in accordance with ASTM D7877 or ASTM D8231. Areas that are ELD tested should be covered immediately
 - b. Verify that the structure can support the deadload weight of a water test before testing.

- c. If leaks should occur the water shall be drained completely and the membrane installation repaired.
2. In the event of damage to the membrane assembly, Electronic Leak Detection testing shall be required to repaired areas prior to the placement of subsequent overburden.

3.11 CLEANING AND PROTECTION

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Retain first paragraph below when board insulation or insulation drainage panels are required and may be exposed for a period on plaza decks.
- C. Protect installed **[board insulation]** **[insulation drainage panels]** from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 16 13

CEMENTITIOUS WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes acrylic latex modified cement waterproofing in water features.
- B. Related requirements: Division 3 for cast-in-place concrete.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing:
 - 1. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.
- B. Pre-installation meeting:
 - 1. Convene minimum two weeks prior to starting work of this section.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square representing actual product, color, and patterns.
- C. Certificate: Manufacturer certification that proposed materials, details and systems, indicated and specified, comply with manufacturer's details and specifications.
- D. Data: Manufacturer Product Data including installation instructions.
- E. Warranty: Manufacturer's warranty form.
- F. Closeout: 2 copies of the warranties to the Owner.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.
- B. Installer Qualifications: Minimum 2 year experience installing similar products.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.

2. Do not proceed with remaining work until workmanship is approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.05 HANDLING

- A. Deliver and store in a dry area between 40- and 90-degree F.
- B. Handle and protect from direct sun light in accordance with manufacturer's instructions.
- C. Deliver materials in manufacturer's unopened containers, fully identified with brand, type, grade, class and other qualifying information.
- D. Take necessary precautions to keep products clean, dry and free of damage.

1.06 PROJECT CONDITIONS

- A. Maintain surfaces to be waterproofed and surrounding air temperature at not less than 40-degree F.
- B. Apply waterproofing only when surface and ambient temperatures are 40-degree F and rising. At temperatures above 85-degree F and above, protect application from direct sun and wind to prevent premature surface drying and shrinkage cracks.
- C. Apply only when temperatures are steady or rising.
- D. Do not apply materials to frosted surfaces.

1.07 WARRANTY

- A. General:
 1. The warranties are governed by the requirements herein, those of Section 01 17 40, and the General Conditions of the Contract.
 2. Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Manufacturer's standard form in which manufacturer and installer agrees to repair or replace components of crystalline waterproofing that fail in materials or workmanship within specified warranty period.
 1. Failures include but are not limited to failure to maintain watertight (defined as the presence of moisture or dampness) conditions within specified warranty period.
 2. Warranty Period: 5 years from date of Substantial Completion.
 3. Should any defects develop, or any leaks occur in the Work within the guarantee period, such defects or leaks shall at once be remedied and made good without cost or expense to the Owner.
 - a. Leaks are defined as the presence of dampness on the face of the foundation wall inboard of the membrane and the top of the wearing slab.

PART 2 PRODUCTS

2.01 MANUFACTURER / MATERIAL

- A. Aquafin, Inc. 2K/M.

2.02 MATERIALS

- A. Waterproofing: Aquafin-2K/M.acrylic modified cement waterproofing, 2-component, acrylic emulsion based, flexible, crack bridging waterproofing membrane barrier.
 - 1. Color: Selected by Architect [from standard color char.]
- B. Patching compound: Aquafin Mortar-LN pre-blended, cementitious waterproofing and repair mortar for honeycombs, forming coves, etc.
- C. Reinforcing mesh: Aquafin-2K-Fabric polypropylene non-woven fleece.
- D. Crack and joint sealing tape: Aquafin “Joint Sealing Tape-2000,” elastomeric tear-resistant, breathable waterproofing tape.
- E. Expansion joint sealing tape: Aquafin “Joint Sealing Tape-2000-S,” elastomeric, tear-resistant, breathable waterproofing tape.
- F. Sealing gasket for PVC pipe and other penetrations: Aquafin-“Gasket 18/18” elastomeric, tear-resistant, breathable waterproofing sealing gasket.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which waterproofing materials are to be installed.
- B. Correct unsatisfactory conditions before proceeding with waterproofing application.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Substrate preparation:
 - 1. Remove oil, grease, dirt, loose particles, remains of form oils, water repellents, rust or other coatings by high-pressure water blasting (>3000 psi), wet or dry sand blasting, or other mechanical means to produce surfaces suitable for application of waterproofing.
 - 2. Follow manufacturer's instructions to clean and prepare surfaces and seal cracks and joints.
 - 3. Voids in concrete substrates:
 - a. One-quarter-inch diameter and larger: Pre-treat with a cementitious mortar.
 - b. Less than 1/4-inch in diameter: Fill with waterproofing material.
- C. Saturate surfaces to be waterproofed with clean water; do not waterproof where standing water is present.

3.03 INSTALLATION

- A. Mix 2-component waterproofing material in proportions recommended by manufacturer.
- B. Taping:

1. Apply waterproofing material by brush in a 6- to 7-inch wide strip coat centered over joints, cracks, penetrations and changes of plane to be taped.
 2. While coat is wet, unroll tape in the coating and apply a coat of waterproofing material over the tape, smoothing out wrinkles and fish mouths.
- C. Waterproofing: Apply waterproofing material in the total thickness specified below in accordance with its manufacturer recommendations:
1. Thickness of finished system for water level up to 2-feet: 60 mils.
 2. For water depth greater than 2-feet: 90 mils.
 3. Application thickness shall not exceed 120 mils.
 4. Apply with stainless steel trowel, tampico brush, short nap roller or spray equipment.
 5. In areas with movement or cracking, the waterproofing material shall be additionally reinforced with mesh embedded between 2 waterproofing layers.
 6. Apply material in 2 coats minimum.
 7. Do not bridge cracks greater than 1/16-inch. Bridge dynamic cracks or joints with elastomeric joint sealing tape, as supplied by waterproofing manufacturer.
 8. Prime and protect alkali sensitive metals such as copper, aluminum, galvanized or zinc treated metal before coating with waterproofing material. Follow manufacturer's recommendations for primer material.
- D. Curing:
1. Follow manufacturer's instructions. Do not use water for curing; waterproofing material is self-curing.
 2. Protect surfaces from rain, frost and premature dehydration; cover with polyethylene film with taped joints to retard water evaporation.
 3. Protect from hot and windy conditions during curing.
- E. Precaution: Do not overcoat the waterproofing with solvent-based materials.
- 3.04 FIELD QUALITY CONTROL
- A. When waterproofing work is complete, fill water feature to normal "in use" depth with water and hold for 48 hours without loss due to leakage.
 - B. Should leak appear, repair as directed by the manufacturer and in a manner acceptable to the Architect.
- 3.05 CLEANING
- A. Clean adjacent surfaces and materials.

END OF SECTION

SECTION 07 18 00
TRAFFIC COATINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Traffic coatings and pavement markings for the following applications:
1. Pedestrian traffic.
 2. Vehicular traffic.
 3. Equipment-room floor.
- B. Related Requirements:
1. Section 07 19 00 "Water Repellents" for penetrating and film-forming water repellents applied on traffic-bearing surfaces.
 2. Section 09 67 23 "Resinous Urethane and Epoxy Mortar" for fluid-applied, **[decorative]** **[general-use commercial]** **[general-use industrial]** **[high-performance]** resinous flooring that does not serve as a waterproofing membrane with integral wearing surface.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

- A. Product Data: Traffic coatings and pavement markings for the following applications:
1. Pedestrian traffic.
 2. Vehicular traffic.
 3. Equipment-room floor.
- B. Product Data Submittals: For each product.
1. Include installation instructions and details, material descriptions, dry- or wet-film thickness requirements, and finish.
- C. Shop Drawings: For traffic coatings.
1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions that are not included in manufacturer's product data.
 2. Include plans showing layout of pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For each type of exposed finish, prepared on rigid backing.
1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of traffic coating.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build mockup for each traffic coating and substrate to receive traffic coatings.
 - 2. Size: **[200 sq. ft.] <Insert dimension>** of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.
 - 1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
- B. Do not install traffic coating until items that penetrate membrane have been installed.
- C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **[40 deg F for oil-based materials] [50 deg F for water-based materials]**, and not exceeding 95 deg F.

1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Adhesive or cohesive failures.
 - b. Abrasion or tearing failures.
 - c. Surface crazing or spalling.
 - d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
2. Warranty Period: **[Five]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain traffic coatings from single source from single manufacturer.
- B. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.
- C. Obtain pavement-marking paint from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.03 TRAFFIC COATINGS

- A. Traffic Coating <Insert drawing designation>: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for **[pedestrian traffic] [vehicular traffic] [and] [equipment-room floor]** <Insert requirement> service condition; according to ASTM C957/C957M.
- B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.
 1. Material: **[Epoxy] [Polyurethane]**.
- C. Preparatory and Base Coats: **[Polyurethane] [Aromatic urethane] [Aliphatic urethane] [or] [epoxy]**.
 1. Thicknesses: Minimum **[dry-] [or] [wet-]**film thickness **[as recommended in writing by manufacturer for substrate and service conditions indicated]** <Insert thickness>.
- D. Intermediate Coat: **[Polyurethane] [Aromatic urethane] [Aliphatic urethane] [or] [epoxy]**.
 1. Thicknesses: Minimum **[dry-] [or] [wet-]**film thickness **[as recommended in writing by manufacturer for substrate and service conditions indicated]** <Insert thickness>, measured excluding aggregate.

2. Aggregate Content: [As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated] [Not less than **8 to 10 lb/100 sq. ft.**] [To refusal] <Insert requirement>.
- E. Topcoat: **[Polyurethane] [Aromatic urethane] [Aliphatic urethane] [Aromatic urethane with UV inhibitors] [or] [epoxy]**.
1. Thicknesses: Minimum [dry-] [or] [wet-]film thickness [as recommended in writing by manufacturer for substrate and service conditions indicated] <Insert thickness>, measured excluding aggregate.
 2. Aggregate Content: [As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated] [As required to achieve slip-resistant finish] **[8 to 10 lb/100 sq. ft.]** [To refusal] <Insert requirement>.
 3. Color: [As selected by Architect from manufacturer's full range] [Match Architect's sample] <Insert color>.
- F. Aggregate: **[Manufacturer's standard aggregate for each use indicated] [Uniformly graded, washed silicon carbide sand] [Uniformly graded, washed silica sand] [Uniformly graded, washed flint shot silica] [Walnut shell granules] [or] [Aluminum-oxide grit]** <Insert aggregate> of particle sizes, shape, and minimum hardness recommended in writing by traffic-coating manufacturer.
- G. Fire-Test-Response Characteristics: Provide traffic-coating materials with the fire-test-response characteristics as determined by testing identical products according to test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.
1. **[Class A] [Class B] [Class C]** roof covering according to ASTM E108.
 2. <Insert test requirement>.
- H. Energy Star Listing: Provide traffic coating that is listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products.
- I. Energy Performance: Provide traffic coating with an initial Solar Reflectance Index of **[not less than 0.70]** <Insert value> and emissivity of **[not less than 0.75]** <Insert value> when tested according to CRRC-1.

2.04 ACCESSORY MATERIALS

- A. Joint Sealants: **[As specified in Section 07 92 00 "Joint Sealants."]** [ASTM C920.] <Insert requirement.>
- B. Sheet Flashing: Nonstaining **[sheet material recommended in writing by traffic-coating manufacturer]** [, uncured neoprene sheet] [, cured neoprene sheet] <Insert material>.
 1. Thickness: Minimum **[60 mils] [50 mils]** <Insert value>.
- C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.
- D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

2.05 PAVEMENT MARKINGS

- A. Pavement-Marking Paint Specified Elsewhere: Comply with Section 32 17 23 "Pavement Markings."

- B. Pavement-Marking Paint:
1. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, **[Type N] [Type F] [Type S]**; colors complying with FS TT-P-1952.
 2. MPI #32 Alkyd Traffic Marking Paint.
 3. Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than **[three] [45]** minutes.
 4. MPI #97 Latex Traffic Marking Paint.
 5. Color: **[White] [Yellow] [Blue] [As indicated]** <Insert color>.
- C. Glass Beads: **[AASHTO M 247, Type 1] [FS TT-B-1325, Type 1A]**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.
- B. Verify that substrates are visibly dry and free of moisture.
1. Test for moisture according to ASTM D4263.
 2. Test for moisture content by **[measuring with an electronic moisture meter] [method recommended in writing by traffic-coating manufacturer]** <Insert test method>.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Begin coating application only after substrate construction and penetrating work have been completed.
 2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
 3. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Clean and prepare substrates according to ASTM C1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.
- B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.
1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.

- C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.
- D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.
- E. Concrete Substrates: **[Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D4259.]** Do not acid etch.
 - 1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 - 2. Remove concrete fins, ridges, and other projections.
 - 3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
 - 4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D4258.

3.03 TERMINATIONS AND PENETRATIONS

- A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C1127 and manufacturer's written instructions.
- B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
- C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
- D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.04 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.
 - 1. Comply with recommendations in ASTM C1193 for joint-sealant installation.
- B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.05 INSTALLATION OF TRAFFIC COATINGS

- A. Apply traffic coating according to ASTM C1127 and manufacturer's written instructions.
- B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.
- C. Start traffic-coating application in presence of manufacturer's technical representative.
- D. Verify that wet-film thickness of each coat complies with requirements every **[100 sq. ft.]** **<Insert dimension>**.

- E. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.
- F. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.
- G. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.06 INSTALLATION OF PAVEMENT MARKINGS

- A. Do not apply pavement-marking paint for striping and other markings until layout, colors, and placement have been verified with Architect and traffic coating has cured.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply pavement-marking paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges. Apply at manufacturer's recommended rates for a minimum wet-film thickness of 15-mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
 - 2. Broadcast glass beads uniformly into wet pavement-marking paint at a rate of 6 lb/gal..

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform the following field tests and inspections:
 - 1. Materials Testing:
 - a. Samples of material delivered to Project site are to be taken, identified, sealed, and certified in presence of **[Owner and]**Contractor.
 - b. Testing agency must perform tests for characteristics specified, using applicable referenced testing procedures.
 - c. Testing agency must verify thickness of coatings during traffic-coating application for each **[600 sq. ft.] <Insert dimension>** of installed traffic coating or part thereof.
 - 2. Electronic Leak-Detection Testing:
 - a. Testing agency must test **[each deck area]** **[each deck area indicated for testing on Drawings]** **<Insert area to be tested>** for leaks using an electronic leak-detection method that locates discontinuities in the traffic-coating membrane.
 - b. Testing agency must perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.
 - c. Testing agency must create a conductive electronic field over the area of traffic coating to be tested and electronically determine locations of discontinuities or leaks, if any, in the traffic coating.

- d. Testing agency must provide survey report indicating locations of discontinuities, if any.
 - B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
 - C. Waterproofing will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.08 PROTECTING AND CLEANING
- A. Protect traffic coatings from damage and wear during remainder of construction period.
 - B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 19 00
WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Penetrating water repellents.
2. Film-forming water repellents.

B. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for integral water-repellent admixture for unit masonry assemblies.

1.02 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Penetrating water repellents.
2. Film-forming water repellents.
3. MPI-approved water repellents.

B. Product Data Submittals:

1. Include manufacturer's printed statement of VOC content.
2. Include manufacturer's standard colors.
3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
4. Include printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies water repellents approved by MPI, with the proposed product highlighted.

- C. Samples: For each type **[and color]** of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Applicator]** **[testing agency]**.

- B. Product Certificates: For each type of water repellent.
- C. Preconstruction Test Reports: For water-repellent-treated substrates.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."
- C. Mockups: Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, **[for preconstruction testing,]** and to set quality standards for materials and execution.
 - 1. Locate mockups **[where shown on Drawings] [on masonry sample panels] [on existing surfaces where directed by Architect] [in locations that enable viewing under same conditions as the completed Work] <Insert requirement>**.
 - a. Size: **[10 sq. ft.] [25 sq. ft.] <Insert size>** each.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing of water repellents on **[field mockups] [manufacturer's standard substrate assemblies] [on existing substrate assemblies]**.
 - 1. In addition to verifying performance requirements, use mockups to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
 - 2. Propose changes to materials and methods to suit Project.
 - 3. Notify Architect **[seven] <Insert number>** days in advance of the dates and times when mockups will be tested.

1.07 FIELD CONDITIONS

- A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied in accordance with manufacturers' written instructions and warranty requirements:
 - 1. Concrete surfaces and mortar have cured for not less than 28 days.

2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. Ambient temperature is above 40 deg F and below 100 deg F and will remain so for 24 hours.
4. Substrate is not frozen and substrate-surface temperature is above 40 deg F and below 100 deg F.
5. Rain or snow is not predicted within 24 hours.
6. Not less than **[24 hours]** **[seven days]** have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.
8. <Insert restriction>.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which **[manufacturer]** **[and]** **[Applicator]** agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.
1. Warranty Period: **[Two]** **[Five]** **<Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Performance: Water repellents must meet the following performance requirements as determined by **[preconstruction]** testing on **[manufacturer's standard]** substrates representing those indicated for this Project.
- B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested according to the following:
1. Cast-in-Place Concrete: ASTM C642.
 2. Precast Concrete: ASTM C642.
 3. Cast Stone: ASTM C1195.
 4. Concrete Masonry Units: ASTM C140.
 5. Clay Brick: ASTM C67.
 6. Natural Stone: ASTM C97/C97M.
 7. Portland Cement Plaster (Stucco): ASTM D6532.

- C. Water-Vapor Transmission: Comply with one or both of the following:
 - 1. Maximum 10 percent reduction in water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM E96/E96M.
 - 2. Minimum 80 percent water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM D1653.
- D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, in accordance with ASTM E514/E514M.
- E. Durability: Maximum 5 percent loss of water-repellent performance after 2,500 hours of weathering in accordance with ASTM G154 compared to water-repellent-treated specimens before weathering.
- F. Chloride-Ion Intrusion in Concrete: NCHRP Report 244, Series II tests.
 - 1. Reduction of Water Absorption: **[80]** <Insert number> percent.
 - 2. Reduction in Chloride Content: **[80]** <Insert number> percent.

2.02 PENETRATING WATER REPELLENTS

- A. Penetrating Low-VOC Silane Water Repellent: Clear, containing **[20]** **[40]** **[100]** <Insert number> percent or more active content of **[modified]** silane; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.
- B. Penetrating Low-VOC Siloxane Water Repellent: Clear, containing **[10]** **[12]** <Insert number> percent or more active content of **[modified]** siloxane; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.
- C. Penetrating Low-VOC Silane/Siloxane-Blend Water Repellent: Clear, containing 100 percent active content of silane and siloxane blend with Zero g/L of VOCs.
 - 1. Rainguard International: Micro-Seal Water Repellant (One Coat). For first coat on unpainted wood and masonry surfaces.
 - 2. Approved Equal.
- D. Penetrating Low-VOC Siliconate Water Repellent: Clear, methyl siliconate water repellent with 400 g/L or less of VOCs.
- E. Penetrating Water and Oil Repellent: Clear, oleophobic water repellent; with 400 g/L or less of VOCs.
- F. Penetrating Water Repellent and Corrosion Inhibitor: Clear, containing **[100]** <Insert number> percent or more active content of modified **[silane]** **[siloxane]** water repellent and corrosion inhibitor, with 400 g/L or less of VOCs.
- G. Penetrating Water Repellent for Calcareous Stone: Clear, modified silane with ethyl silicate, specially formulated for limestone and marble.
- H. Penetrating Water Repellent Concentrate: Concentrated **[siloxane]** **[silane]**, for field dilution.

2.03 FILM-FORMING WATER REPELLENTS

- A. Film-Forming Low-VOC Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 400 g/L or less of VOCs.
- B. Film-Forming Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 600 g/L or less of VOCs.
- C. Film-Forming Water Repellent for Masonry: **[Clear] [Pigmented]**, consisting of resins, acrylics, polymers, with 600 g/L or less of VOCs; for masonry block or brick.
 - 1. Color: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.
- D. Film-Forming Low-VOC Modified Acrylic Water Repellent: **[Clear] [Pigmented]**, breathing coating of acrylic resin, which may be enhanced with silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 400 g/L or less of VOCs.
 - 1. Color: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.
- E. Film-Forming Modified Acrylic Water Repellent: **[Clear] [Pigmented]**, breathing coating of acrylic resins, which may be enhanced silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 600 g/L or less of VOCs.
 - 1. Color: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
 - 1. Verify that surfaces are clean and dry in accordance with water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
 - 2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
 - 3. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Test pH level in accordance with water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, in accordance with repellent manufacturer's written instructions.
- B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product in accordance with water-repellent manufacturer's written instructions and as follows:
 - 1. **[Cast-in-Place Concrete] [Precast Concrete] [Cast Stone] [and] [Concrete Unit Masonry]**: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents in accordance with ASTM E1857 **<Insert requirement>**.
 - 2. Clay Brick Masonry: ASTM D5703.
 - 3. Natural Stone: ASTM C1515.
 - 4. Portland Cement Plaster (Stucco): ASTM E1857.
- C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.
- D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.
- E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
 - 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.03 APPLICATION OF WATER REPELLENTS

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
- B. Apply coating of water repellent on surfaces to be treated using 15 psi-pressure spray with a fan-type spray nozzle, roller, or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
 - 1. **[Precast Concrete] [and] [Cast Stone]**: At Contractor's option, first application of water repellent may be completed before installing units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto joint surfaces. Remove masking after repellent has cured.
- C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.04 FIELD QUALITY CONTROL

- A. Testing of Water-Repellent Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:
1. Owner will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
 3. Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor to remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect. **<Insert additional requirements to suit Project>**.
- B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
1. Notify Architect seven days in advance of the dates and times when surfaces will be tested.
 2. Reapply water repellent until coverage test indicates complete coverage.

3.05 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.
- B. Comply with manufacturer's written cleaning instructions.

END OF SECTION

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SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Molded (expanded) polystyrene foam-plastic board insulation.
3. Graphite-polystyrene foam-plastic board insulation.
4. Polyisocyanurate foam-plastic board insulation.
5. Glass-fiber blanket insulation.
6. Glass-fiber board insulation.
7. Mineral-wool blanket insulation.
8. Mineral-wool board insulation.
9. Loose-fill insulation.
10. Spray-applied cellulosic insulation.
11. Cellular glass insulation.
12. Reflective insulation.

B. Related Requirements:

1. Section 04 22 00 "Concrete Unit Masonry" for insulation installed in masonry cells.
2. Section 06 16 00 "Sheathing" for foam-plastic board sheathing installed directly over wood or steel framing.
3. **[Section 07 13 26 "Self-Adhering Sheet Waterproofing"] [Section 07 13 54 "Thermoplastic Sheet Waterproofing"] [Section 07 14 13 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"]** for insulated drainage panels installed with plaza deck insulation.
4. **[Section 07 52 16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"] [Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing"] [Section 07 55 52.16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing"]** for insulation specified as part of roofing construction.
5. **[Section 09 24 00 "Cement Plastering"] [Section 09 29 00 "Gypsum Board"]** for sound attenuation blanket used as acoustic insulation.

1.02 ACTION SUBMITTALS

A. Product Data:

1. Extruded polystyrene foam-plastic board insulation.

2. Molded (expanded) polystyrene foam-plastic board insulation.
3. Graphite-polystyrene foam-plastic board insulation.
4. Polyisocyanurate foam-plastic board insulation.
5. Glass-fiber blanket insulation.
6. Glass-fiber board insulation.
7. Mineral-wool blanket insulation.
8. Mineral-wool board insulation.
9. Loose-fill insulation.
10. Spray-applied cellulosic insulation.
11. Cellular glass insulation.
12. Reflective insulation.

1.03 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
 1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
 2. Sign, date, and post the certification in a conspicuous location on Project site.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements; provide products by one of the following:
1. Johns Manville (Basis of Design).
 2. Atlas Roofing Corporation.
 3. Hunter Panels.
 4. DuPont.
 5. Firestone Building Products.
 6. Rmax, Inc.
 7. CertainTeed Corporation.
 8. Guardian Building Products, Inc.
 9. Owens Corning.
 10. Approved equal.
- B. Fire propagation characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than **[25 and 450] [75 and 450] [200 and 450]** when tested in accordance with ASTM E84.
- B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.
- C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- D. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
- E. Thermal-Resistance Value (R-Value): **[R-value as indicated on Drawings] [R-value as indicated below] <Insert R-value>** in accordance with ASTM C518.
1. R-Value at **<Insert location>**: **<Insert R-value>**.

2.03 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Extruded Polystyrene Board Insulation, Type X **<Insert drawing designation>**: ASTM C578, Type X, 15-psi minimum compressive strength; unfaced.
- B. Extruded Polystyrene Board Insulation, Type IV **<Insert drawing designation>**: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced.

- C. Extruded Polystyrene Board Insulation, Type IV, Drainage Panels <Insert drawing designation>: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- D. Extruded Polystyrene Board Insulation, Type VI <Insert drawing designation>: ASTM C578, Type VI, 40-psi minimum compressive strength.
- E. Extruded Polystyrene Board Insulation, Type VI, Drainage Panels <Insert drawing designation>: ASTM C578, Type VI, 40-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- F. Extruded Polystyrene Board Insulation, Type VII <Insert drawing designation>: ASTM C578, Type VII, 60-psi minimum compressive strength.
- G. Extruded Polystyrene Board Insulation, Type VII, Drainage Panels <Insert drawing designation>: ASTM C578, Type VII, 60-psi minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
- H. Extruded Polystyrene Board Insulation, Type V <Insert drawing designation>: ASTM C578, Type V, 100-psi minimum compressive strength.

2.04 MOLDED (EXPANDED) POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Molded (Expanded) Polystyrene Board Insulation, Type I <Insert drawing designation>: ASTM C578, Type I, 10-psi minimum compressive strength.
- B. Molded (Expanded) Polystyrene Board Insulation, Type VIII <Insert drawing designation>: ASTM C578, Type VIII, 13-psi minimum compressive strength.
- C. Molded (Expanded) Polystyrene Board Insulation, Type II <Insert drawing designation>: ASTM C578, Type II, 15-psi minimum compressive strength.
- D. Molded (Expanded) Polystyrene Board Insulation, Type IX <Insert drawing designation>: ASTM C578, Type IX, 25-psi minimum compressive strength.
- E. Molded (Expanded) Polystyrene Board Insulation, Type XIV <Insert drawing designation>: ASTM C578, Type XIV, 40-psi minimum compressive strength.
- F. Molded (Expanded) Polystyrene Board Insulation, Type XV <Insert drawing designation>: ASTM C578, Type XV, 60-psi minimum compressive strength.

2.05 GRAPHITE-POLYSTYRENE FOAM-PLASTIC BOARD

- A. Graphite-Polystyrene Foam-Plastic Board, Type I <Insert drawing designation>: ASTM C578, Type I, 10-psi minimum compressive strength; 4-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- B. Graphite-Polystyrene Foam-Plastic Board, Type I, Faced <Insert drawing designation>: ASTM C578, Type I, 10-psi minimum compressive strength; 4-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.

- C. Graphite-Polystyrene Foam-Plastic Board, Type VIII <Insert drawing designation>: ASTM C578, Type VIII, 13-psi minimum compressive strength; 3.1-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- D. Graphite-Polystyrene Foam-Plastic Board, Type VIII, Faced <Insert drawing designation>: ASTM C578, Type VIII, 13-psi minimum compressive strength; 3.1-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- E. Graphite-Polystyrene Foam-Plastic Board, Type II <Insert drawing designation>: ASTM C578, Type II, 15-psi minimum compressive strength; 3.1-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- F. Graphite-Polystyrene Foam-Plastic Board, Type IX <Insert drawing designation>: ASTM C578, Type IX, 25-psi minimum compressive strength; 2.5-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- G. Graphite-Polystyrene Foam-Plastic Board, Type IX, Faced <Insert drawing designation>: ASTM C578, Type IX, 25-psi minimum compressive strength; 2.5-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- H. Graphite-Polystyrene Foam-Plastic Board, Type XIV <Insert drawing designation>: ASTM C578, Type XIV, 40-psi minimum compressive strength; 2.5-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- I. Graphite-Polystyrene Foam-Plastic Board, Type XV <Insert drawing designation>: ASTM C578, Type XV, 60-psi minimum compressive strength; 2.5-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- J. Graphite-Polystyrene Foam-Plastic Board, Type X, Faced <Insert drawing designation>: ASTM C578, Type X, 15-psi minimum compressive strength; 1.1-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.
- K. Graphite-Polystyrene Foam-Plastic Board, Type IV, Faced <Insert drawing designation>: ASTM C578, Type IV, 25-psi minimum compressive strength; 1.1-perm maximum vapor permeance at 1-inch thickness per ASTM E96/E96M.

2.06 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Polyisocyanurate Board Insulation, Foil Faced <Insert drawing designation>: ASTM C1289, foil faced, Type I, Class 1 or 2.
- B. Polyisocyanurate Board Insulation, Glass-Fiber-Mat Faced <Insert drawing designation>: ASTM C1289, glass-fiber-mat faced, Type II, Class 2.

2.07 GLASS-FIBER BLANKET INSULATION

- A. Glass-Fiber Blanket Insulation, Unfaced <Insert drawing designation>: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.
- B. Glass-Fiber Blanket Insulation, Polypropylene-Scrim-Kraft Faced <Insert drawing designation>: ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

- C. Glass-Fiber Blanket Insulation, Kraft Faced <Insert drawing designation>: ASTM C665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).
- D. Glass-Fiber Blanket Insulation, Reinforced-Foil Faced <Insert drawing designation>: ASTM C665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
- E. Glass-Fiber Blanket Insulation, Foil Faced <Insert drawing designation>: ASTM C665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.08 GLASS-FIBER BOARD INSULATION

- A. Glass-Fiber Board Insulation, Unfaced <Insert drawing designation>: ASTM C612, Type IA; unfaced [, passing ASTM E136 for combustion characteristics].
 - 1. Nominal Density: [2.25 lb/cu. ft.] [3 lb/cu. ft.] [4.25 lb/cu. ft.] [6 lb/cu. ft.] <Insert value>.
- B. Glass-Fiber Board Insulation, Faced <Insert drawing designation>: ASTM C612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder.
 - 1. Nominal Density: [2.25 lb/cu. ft.] [3 lb/cu. ft.] [4.25 lb/cu. ft.] [6 lb/cu. ft.] <Insert value>.

2.09 MINERAL-WOOL BLANKET INSULATION

- A. Mineral-Wool Blanket Insulation, Unfaced <Insert drawing designation>: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
- B. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced <Insert drawing designation>: ASTM C665, Type III (reflective faced); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.10 MINERAL-WOOL BOARD INSULATION

- A. Mineral-Wool Board Insulation, Types IA and IB, Unfaced <Insert drawing designation>: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.
 - 1. Nominal Density: [1.6 lb/cu. ft.] [2.25 lb/cu. ft.] [3 lb/cu. ft.] [4 lb/cu. ft.] [4.3 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] <Insert value>.
- B. Mineral-Wool Board Insulation, Types IA and IB, Faced <Insert drawing designation>: ASTM C612, Types IA and IB; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.
 - 1. Nominal Density: [1.6 lb/cu. ft.] [2.25 lb/cu. ft.] [3 lb/cu. ft.] [4 lb/cu. ft.] [4.3 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] <Insert value>.

- C. Mineral-Wool Board Insulation, Type II, Unfaced <Insert drawing designation>: ASTM C612, Type II; passing ASTM E136 for combustion characteristics.
1. Nominal Density: **[4 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] <Insert value>**.
- D. Mineral-Wool Board Insulation, Type II, Faced <Insert drawing designation>: ASTM C612, Type II; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.
1. Nominal Density: **[4 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] <Insert value>**.
- E. Mineral-Wool Board Insulation, Type III, Unfaced <Insert drawing designation>: ASTM C612, Type III; passing ASTM E136 for combustion characteristics.
1. Nominal Density: **[4 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] [10 lb/cu. ft.] <Insert value>**.
- F. Mineral-Wool Board Insulation, Type III, Faced <Insert drawing designation>: ASTM C612, Type III; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.
1. Nominal Density: **[4 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] [10 lb/cu. ft.] <Insert value>**.
- G. Mineral-Wool Board Insulation, Type IVA <Insert drawing designation>: ASTM C612, Type IVA; **[unfaced] [with black mat facer] <Insert facer material>**.
1. Nominal Density: **[4 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] [10 lb/cu. ft.] [11 lb/cu. ft.] [12 lb/cu. ft.] <Insert value>**.
- H. Mineral-Wool Board Insulation, Type IVB <Insert drawing designation>: ASTM C612, Type IVB; **[unfaced] [with black mat facer] <Insert facer material>**.
1. Nominal Density: **[4.3 lb/cu. ft.] [6 lb/cu. ft.] [8 lb/cu. ft.] [10 lb/cu. ft.] [11 lb/cu. ft.] [12 lb/cu. ft.] [6.2 lb/cu. ft. outer layer and 3.8 lb/cu. ft. innerlayer] <Insert value>**.

2.11 LOOSE-FILL INSULATION

- A. Cellulosic-Fiber Loose-Fill Insulation <Insert drawing designation>: ASTM C739, chemically treated for flame-resistance, processing, and handling characteristics.
- B. Glass-Fiber Loose-Fill Insulation <Insert drawing designation>: ASTM C764, **[Type I for pneumatic application] [or] [Type II for poured application]**.

2.12 SPRAY-APPLIED CELLULOSIC INSULATION

- A. Self-Supported, Spray-Applied Cellulosic Insulation <Insert drawing designation>: ASTM C1149, **[Type I (materials applied with liquid adhesive; suitable for either exposed or enclosed applications),] [Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications),] [Type III (materials containing an adhesive mixed with water during application; intended for application on attic floors),]** chemically treated for flame-resistance, processing, and handling characteristics.

2.13 CELLULAR GLASS INSULATION

- A. Cellular Glass Insulation <Insert drawing designation>: ASTM C552, **[Type I (flat block)] [Type IV (board)] [faced on both sides with manufacturer's special kraft-paper sheets laminated to glass block with asphalt]**.

2.14 REFLECTIVE INSULATION

- A. Reflective Insulation: ASTM C1224, with one or more low-emittance surfaces with emittance value of 0.1 or less as measured per ASTM C1371.
1. Construction: **[Surfaces separated with internal expanders] [Surfaces separated by single-layer polyethylene bubble film] [Surfaces separated by double-layer polyethylene bubble film] <Insert construction>**.
 2. Water-Vapor Transmission: **[1 perm, maximum] [5 perms or greater]**.
- B. Sheet Radiant Barrier: ASTM C1313/C1313M with at least one surface with emittance value of 0.1 or less as measured per ASTM C1371.
1. Construction: **[Foil on one side of substrate] [Foil on both sides of substrate] [Vacuum metallizing on substrate]**.
 2. Tear Resistance: **<Insert value>**.
 3. Water-Vapor Transmission: **[1 perm, maximum] [5 perms or greater]**.
 4. Sheet Width: **<Insert width>**.
- C. Interior Radiation Control Coating System: Silver-colored, low-emissivity, **[solvent] [water]**-based coating; with a surface emittance value of 0.25 or less as measured per ASTM C1371.

2.15 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
 - 1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
 - d. **<Insert location>**.
- D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of **[1 inch] [2 inches] [3 inches]** between face of insulation and substrate to which anchor is attached.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.16 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
 - 3. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-in-place applications.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- C. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
- D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.03 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of **[24 inches] [36 inches]** **<Insert dimension>** below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of **[24 inches] [36 inches]** **<Insert dimension>** in from exterior walls.

3.04 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
 - 2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
 - 3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
 - 4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
 - 5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.05 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.
 - 1. Fit courses of insulation between [**wall ties and other**] obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04 20 00 "Unit Masonry."
- B. Cellular-Glass Board Insulation: Install with closely fitting joints using [**adhesive pad**] [**serrated trowel**] attachment method according to manufacturer's written instructions.
- C. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches from each corner of board insulation, at center of board, and as recommended by manufacturer.
 - 1. Fit courses of insulation between [**masonry wall ties and other**] obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.

3.06 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 - 5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 - 6. For wood-framed construction, install blankets in accordance with ASTM C1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward **[exterior of construction] [interior of construction] [as indicated on Drawings]**.
 - b. Interior Walls: Set units with facing placed **[as indicated on Drawings] [toward areas of high humidity] <Insert location>**.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- C. Loose-Fill Insulation: Apply in accordance with ASTM C1015 and manufacturer's written instructions.
 1. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
 2. For cellulosic-fiber loose-fill insulation, comply with CIMA's Bulletin #2, "Standard Practice for Installing Cellulose Insulation."
- D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions.
 1. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
 2. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.07 INSTALLATION OF CURTAIN-WALL INSULATION

- A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.
 1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass.
 2. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
 3. Install insulation to fit snugly without bowing.

3.08 INSTALLATION OF REFLECTIVE INSULATION

- A. Install sheet reflective insulation in accordance with ASTM C727.
- B. Install sheet radiant barriers in accordance with ASTM C1744.
- C. Install interior radiation control coating system in accordance with ASTM C1321.

3.09 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

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SECTION 07 26 00

BELOW GRADE VAPOR RETARDERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Polyethylene vapor retarders.
 - 2. Reinforced-polyethylene vapor retarders.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for under-slab vapor retarders.
 - 2. Section 07 21 00 "Thermal Insulation" for vapor retarders integral with insulation products.

1.02 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for vapor barrier and accessories.
 - 1. Polyethylene vapor retarders.
 - 2. Reinforced-polyethylene vapor retarders.
 - 3. Fire-retardant, reinforced-polyethylene vapor retarders.
- B. Shop Drawings: Submit shop drawings for all vapor barrier termination conditions.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 PRODUCTS

2.01 REINFORCED-POLYETHYLENE VAPOR RETARDERS

- A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than **[20 lb/1000 sq. ft.] <Insert weight>**, with maximum permeance rating of 0.1 perm.

2.02 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.02 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Place vapor retarders on side of construction indicated on Drawings.
- B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.
- D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.03 INSTALLATION OF VAPOR RETARDERS IN CRAWL SPACES

- A. Install vapor retarders over prepared grade. Lap joints a minimum of 12 inches and seal with manufacturer's recommended tape. Install second layer over pathways to equipment.
- B. Extend vapor retarder over footings and seal to foundation wall or grade beam with manufacturer's recommended tape.
 - 1. Extend vapor retarder vertically minimum **[16 inches] [24 inches] <Insert dimension>** above top of footing.
- C. Seal around penetrations such as utilities and columns in order to create a monolithic, airtight membrane at grade surface, perimeter, and all vertical penetrations.

3.04 PROTECTION

- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION

SECTION 07 27 15

NON-BITUMINOUS SELF-ADHERING SHEET AIR BARRIERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Self-adhering air barrier.
 - 1. Vapor-retarding non-bituminous sheet.
 - 2. Vapor-permeable non-bituminous sheet.
- B. Related Requirements:
 - 1. Section 06 16 00 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
 - 2. Section 07 25 00 "Weather Barriers" for weather barriers, including [building paper] [flexible flashing] [and] [building wraps with air-barrier properties].

1.02 DEFINITIONS

- A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.
- C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.04 ACTION SUBMITTALS

- A. Product Data: Self-adhering air barrier. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.
 - 1. Vapor-retarding non-bituminous sheet.
 - 2. Vapor-permeable non-bituminous sheet.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
 - 2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

3. Include details of interfaces with other materials that form part of air barrier.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer. [Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.]
- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.
- D. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution [and for preconstruction testing].
 1. Build integrated mockups of exterior wall assembly [as indicated on Drawings] [, 150 sq. ft.] <Insert requirement>, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane [, building corner condition,] [and] [foundation wall intersection].
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: [Owner will engage] [Engage] a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier assemblies to comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [ASTM E1186, chamber pressurization or depressurization with smoke tracers] [ASTM E1186, chamber depressurization with detection liquids] <Insert requirement>.
2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [ASTM E783] [or] [ASTM E2357].
3. Adhesion Testing: Mockups will be tested for required air-barrier adhesion to substrate in accordance with ASTM D4541.
4. Notify Architect [seven] <Insert number> days in advance of the dates and times when mockups will be tested.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
 1. Protect substrates from environmental conditions that affect air-barrier performance.
 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier [and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration]. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [, tie-ins to installed waterproofing], and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum [0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.] <Insert value>, when tested in accordance with ASTM E2357.

2.03 NONBITUMINOUS SHEET AIR BARRIER

- A. Vapor-Retarding Non-Bituminous Sheet: Minimum 10-mil-thick, self-adhering sheet consisting of 5 mils of air-barrier film and a 5-mil-thick, acrylic adhesive with release liner on adhesive side [and formulated for application with primer that complies with VOC limits].
 1. Physical and Performance Properties:

- a. Air Permeance: Maximum [0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft.] <Insert value> pressure difference; ASTM E2178.
 - b. Puncture Resistance: Minimum [40 lbf] <Insert value>; ASTM E154/E154M.
 - c. Vapor Permeance: Maximum [1.0 perm] <Insert value>; ASTM E96/E96M, Desiccant Method.
 - d. Adhesion to Substrate: Minimum [16 lbf/sq. in.] <Insert value> when tested in accordance with ASTM D4541 as modified by ABAA.
 - e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - f. UV Resistance: Can be exposed to sunlight for [150] <Insert number> days in accordance with manufacturer's written instructions.
- B. Vapor-Permeable Non-Bituminous Sheet: Minimum 20-mil-thick, self-adhering sheet consisting of a breathable carrier film or fabric and an adhesive with release liner on adhesive side [and formulated for application with primer that complies with VOC limits].
1. Physical and Performance Properties:
 - a. Air Permeance: Maximum [0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft.] <Insert value> pressure difference; ASTM E2178.
 - b. Puncture Resistance: Minimum [40 lbf] <Insert value>; ASTM E154/E154M.
 - c. Vapor Permeance: Minimum [15 perms] <Insert value>; ASTM E96/E96M, Desiccant Method, Procedure A.
 - d. Adhesion to Substrate: Minimum [16 lbf/sq. in.] <Insert value> when tested in accordance with ASTM D4541 as modified by ABAA.
 - e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - f. UV Resistance: Can be exposed to sunlight for [50] [150] <Insert number> days in accordance with manufacturer's written instructions.

2.04 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Primer: Liquid [waterborne] [solvent-borne] primer recommended for substrate by air-barrier material manufacturer.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, [0.0187 inch] [0.0250 inch] <Insert dimension> thick, and Series 300 stainless steel fasteners.
- D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
 - 3. Verify that substrates are visibly dry and free of moisture. [Test concrete substrates for capillary moisture by plastic sheet method in accordance with ASTM D4263.]
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge [isolation joints] [expansion joints] [and] [discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints] with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.03 INSTALLATION OF NONBITUMINOUS SHEET AIR BARRIER

- A. Install materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
- B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic.

- C. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
- D. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
 - 1. Apply sheets in a shingled manner to shed water.
 - 2. Roll sheets firmly to enhance adhesion to substrate.
- E. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.
- F. CMU: Install air-barrier sheet horizontally against the CMU beginning at base of wall. Align top edge of air-barrier sheet immediately below protruding masonry ties or joint reinforcement or ties, and firmly adhere in place.
 - 1. Overlap horizontally adjacent sheets a minimum of 2 inches and roll seams.
 - 2. Apply overlapping sheets with bottom edge slit to fit around masonry reinforcing or ties. Roll firmly into place.
 - 3. Seal around masonry reinforcing or ties and penetrations with termination mastic.
 - 4. Continue the sheet into all openings in the wall, such as doors and windows, and terminate at points to maintain an airtight barrier that is not visible from interior.
- G. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch-wide, transition strip.
- H. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- I. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
 - 1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- J. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- K. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.
- L. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- M. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [transition strip] [preformed silicone extrusion] so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
 2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
- N. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- O. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.
- P. Do not cover air barrier until it has been tested and inspected by testing agency.
- Q. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.
- 3.04 FIELD QUALITY CONTROL
- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. [Inspections may include the following:]
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Continuous structural support of air-barrier system has been provided.
 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 4. Site conditions for application temperature and dryness of substrates have been maintained.
 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 6. Surfaces have been primed.
 7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
 8. Termination mastic has been applied on cut edges.
 9. Air barrier has been firmly adhered to substrate.
 10. Compatible materials have been used.
 11. Transitions at changes in direction and structural support at gaps have been provided.
 12. Connections between assemblies (air barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 13. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage in accordance with [ASTM E1186, chamber pressurization or depressurization with smoke tracers] [ASTM E1186, chamber depressurization using detection liquids] <Insert requirement>.
 2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [ASTM E783] [or] [ASTM E2357] <Insert test>.
 3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate in accordance with ASTM D4541 for each [600 sq. ft.] <Insert value> of installed air barrier or part thereof.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.
- 3.05 CLEANING AND PROTECTION
- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

SECTION 07 27 26

FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. High-build air barriers, vapor retarding.
2. High-build air barriers, vapor permeable.
3. Medium-build air barriers, vapor retarding.
4. Medium-build air barriers, vapor permeable.

B. Related Requirements:

1. Section 06 16 00 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
2. Section 07 25 00 "Weather Barriers" for weather barriers, including [building paper] [flexible flashing] [and] [building wraps with air-barrier properties].

1.02 DEFINITIONS

- A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.
- C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.04 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.
 1. High-build air barriers, vapor retarding.
 2. High-build air barriers, vapor permeable.
 3. Medium-build air barriers, vapor retarding.
 4. Medium-build air barriers, vapor permeable.

- B. Shop Drawings: For air-barrier assemblies.
 - 1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
 - 2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 3. Include details of interfaces with other materials that form part of air barrier.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer. [Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.]
- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.
- D. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution [and for preconstruction testing].
 - 1. Build integrated mockups of exterior wall assembly [as indicated on Drawings] [, 150 sq. ft.] <Insert requirement>, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane [, building corner condition,] [and] [foundation wall intersection].
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: [Owner will engage] [Engage] a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier assemblies must comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
 - 1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [ASTM E1186, chamber pressurization or depressurization with smoke tracers] [ASTM E1186, chamber depressurization with detection liquids] <Insert requirement>.
 - 2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [ASTM E783] [or] [ASTM E2357].
 - 3. Adhesion Testing: Mockups will be tested for required air-barrier adhesion to substrate in accordance with ASTM D4541.
 - 4. Notify Architect [seven] <Insert number> days in advance of the dates and times when mockups will be tested.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain primary air-barrier materials and air-barrier accessories from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier [and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration]. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [, tie-ins to installed waterproofing], and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum [0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.] <Insert value>, when tested in accordance with ASTM E2357.
- C. Air Permeance: Maximum [0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.] <Insert value> pressure difference; ASTM E2178.

- D. Ultimate Elongation: Minimum [200] [250] [350] [500] <Insert number> percent; ASTM D412, Die C.
- E. Adhesion to Substrate: Minimum [16 lbf/sq. in.] [30 lbf/sq. in.] <Insert value> when tested in accordance with ASTM D4541.
- F. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- G. UV Resistance: Can be exposed to sunlight for [30] [60] [90] [180] [240] [360] <Insert number> days in accordance with manufacturer's written instructions.

2.03 HIGH-BUILD AIR BARRIERS, VAPOR RETARDING

- A. High-Build, Vapor-Retarding Air Barrier, Modified Bituminous Type: Modified bituminous membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
- B. High-Build, Vapor-Retarding Air Barrier, Synthetic Polymer Type: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
- C. Vapor Permeance: Maximum [0.1 perm] <Insert value>; ASTM E96/E96M, [Procedure A, Desiccant Method] [Procedure B, Water Method].

2.04 HIGH-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. High-Build, Vapor-Permeable Air Barrier, Modified Bituminous Type: Modified Bituminous membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
- B. High-Build, Vapor-Permeable Air Barrier, Synthetic Polymer Type: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
- C. Vapor Permeance: Minimum [5 perms] <Insert value>; ASTM E96/E96M, [Procedure A, Desiccant Method] [Procedure B, Water Method].

2.05 MEDIUM-BUILD AIR BARRIERS, VAPOR RETARDING

- A. Medium-Build, Vapor-Retarding Air Barrier: Synthetic polymer material with an installed dry film thickness, according to manufacturer's written instructions, of 16 to 34 mils over smooth, void-free substrates.
 - 1. Vapor Permeance: Maximum [0.1 perm] <Insert value>; ASTM E96/E96M, [Procedure A, Desiccant Method] [Procedure B, Water Method].

2.06 MEDIUM-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. Medium-Build, Vapor-Permeable Air Barrier: Synthetic polymer material with an installed dry film thickness, according to manufacturer's written instructions, of 16 to 34 mils over smooth, void-free substrates.
 - 1. Vapor Permeance: Minimum [5 perms] <Insert value>; ASTM E96/E96M, [Procedure A, Desiccant Method] [Procedure B, Water Method].

2.07 ACCESSORY MATERIALS

- A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Primer: Liquid [waterborne] [solvent-borne] primer recommended for substrate by air-barrier material manufacturer.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, [0.0187 inch] [0.0250 inch] <Insert dimension> thick, and Series 300 stainless steel fasteners.
- D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
 - 3. Verify that substrates are visibly dry and free of moisture. [Test concrete substrates for capillary moisture by plastic sheet method in accordance with ASTM D4263.]
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge [isolation joints] [expansion joints] [and] discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.03 INSTALLATION OF ACCESSORIES

- A. Install accessory materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
 - 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [transition strip] [preformed silicone extrusion] so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
 - 1. Transition Strip: Roll firmly to enhance adhesion.
 - 2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
- F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- H. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, transition strip.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

- J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.04 INSTALLATION OF PRIMARY AIR-BARRIER MATERIAL

- A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
 - 1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.
- B. High-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding, High-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements, but not less than 35 mils] [not less than 40 mils] [not less than 45 mils] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats].
 - 2. Vapor-Permeable, High-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements, but not less than 35 mils] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats].
- C. Medium-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding, Medium-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements] [not less than 16 mils] [not less than 34 mils] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats]. Apply additional material as needed to achieve void- and pinhole-free surface.
 - 2. Vapor-Permeable, Medium-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats]. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.
- D. Low-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding, Low-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements] [not less than 15 mils] [not less than 6 mils] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats]. Apply additional material as needed to achieve void- and pinhole-free surface.

2. Vapor-Permeable, Low-Build Air Barrier: Total dry film thickness [as recommended in writing by manufacturer to comply with performance requirements] <Insert dimension>, applied in [one coat] [two equal coats] [one or more equal coats]. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.

- E. Do not cover air barrier until it has been tested and inspected by testing agency.
- F. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.05 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. [Inspections may include the following:]
 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Air-barrier dry film thickness.
 3. Continuous structural support of air-barrier system has been provided.
 4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 5. Site conditions for application temperature and dryness of substrates have been maintained.
 6. Maximum exposure time of materials to UV deterioration has not been exceeded.
 7. Surfaces have been primed, if applicable.
 8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 9. Termination mastic has been applied on cut edges.
 10. Strips and transition strips have been firmly adhered to substrate.
 11. Compatible materials have been used.
 12. Transitions at changes in direction and structural support at gaps have been provided.
 13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 14. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
 1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage in accordance with [ASTM E1186, chamber pressurization or depressurization with smoke tracers] [ASTM E1186, chamber depressurization using detection liquids] <Insert requirement>.

2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [ASTM E783] [or] [ASTM E2357].
 3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate in accordance with ASTM D4541 for each [600 sq. ft.] <Insert value> of installed air barrier or part thereof.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

3.06 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION

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SECTION 07 32 13

CLAY ROOF TILES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Clay roof tiles.
2. Underlayment materials.
3. Ridge vents.
4. Metal flashing and trim.

B. Related Requirements:

1. Section 07 72 53 "Snow Guards" for snow guards.

1.02 ALLOWANCES

- A. See Section 01 21 00 "Allowances" for description of allowances affecting items specified under this Section.

1.03 UNIT PRICES

- A. See Section 01 22 00 "Unit Prices" for description of unit prices affecting items specified under this Section.

1.04 ALTERNATES

- A. See Section 01 23 00 "Alternates" for description of alternates affecting items specified under this Section.

1.05 DEFINITIONS

- A. Roofing Terminology: See ASTM D1079 and glossary in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" for definitions of terms related to roofing Work in this Section.

1.06 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
 1. <Insert participant requirements>.

1.07 ACTION SUBMITTALS

A. Product Data:

1. Clay roof tiles.
2. Underlayment materials.
3. Ridge vents.

4. Metal flashing and trim.
- B. Shop Drawings: For metal flashing and trim.
 - C. Samples: For each exposed product and for each color and texture specified, in sizes indicated.
 1. Clay Roof Tiles: Full size, showing full range of color values and blends.
 2. Accessory Tiles: Full size, each type.
 3. Metal Flashing: 12 inches square.
 4. Ridge Vents: 12-inch-long Sample.
 5. Eave Closures: In manufacturer's standard size.
 - D. Samples for Initial Selection: For each type of clay roof tile and accessory tile.
 1. Include Samples of accessories involving color selection.
 - E. Samples for Verification: For the following products, in sizes indicated:
 1. Clay Roof Tiles: Full size, showing full range of color values and blends.
 2. Accessory Tiles: Full size, each type.
 3. Metal Flashing: 12 inches square.
 4. Ridge Vents: 12-inch-long Sample.
 5. Eave Closures: In manufacturer's standard size.
- 1.08 INFORMATIONAL SUBMITTALS
- A. Material Test Reports: For each type of clay roof tile, based on evaluation of comprehensive tests performed by a qualified testing agency.
 - B. Research Reports: From [an agency acceptable to authorities having jurisdiction] [ICC-ES] <Insert evaluation agency>, indicating that product is suitable for intended use under applicable building codes for the following:
 1. [Mortar] [Adhesive] tile-attachment systems.
 2. Wire-tie tile-attachment systems.
 3. Polymer-modified bitumen sheet underlayment.
 4. Synthetic underlayment.
 - C. Sample Warranty: For manufacturer's materials warranty.
- 1.09 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing to include in maintenance manuals.
 - B. Materials warranties.
 - C. Roofing Installer's warranty.
- 1.10 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Clay Roof Tiles: [100 sq. ft.] <Insert area> of each type, in unbroken bundles.
- 1.11 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for clay roof tiles including related roofing materials.
 - a. Size: **[48 inches long by 48 inches wide]** <Insert dimensions>.
 - b. Include gutter and downspout complying with requirements in **[Section 07 62 00 "Sheet Metal Flashing and Trim.]"** **[Section 07 71 00 "Roof Specialties.]"**
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.
 - 1. Store on end, on pallets or other raised surfaces. Do not double-stack rolls.
- B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.
- C. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.13 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.
 - 1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.14 WARRANTY

- A. Materials Warranty: Manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.
 - 1. Warranty Period: **[50]** **<Insert number>** years from date of Substantial Completion.
- B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of clay-tile roofing that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **[Two]** **[Five]** **<Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain each type of product from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Exterior Fire-Test Exposure: Provide clay roof tiles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
- B. Energy Performance, Energy Star: Provide roof tiles that are listed on the DOE's "Energy Star Roof Product List" for steep-slope roof products.

2.03 CLAY ROOF TILES

- A. Clay Roof Tiles: ASTM C1167, molded- or extruded-clay roof tile units of shape and configuration indicated, kiln fired, and free of surface imperfections. Provide with fastening holes pre-punched at factory before firing. Shape and style of tiles to match current Campus Specification Standards.
 - 1. Durability: [Grade 1] [Grade 2] [Grade 3].
 - 2. High-Profile Shape: Type I, [Spanish or "S"] [two-piece tapered mission] [two-piece straight mission] [two-piece straight barrel mission] [two-piece Greek] [two-piece Roman] <Insert shape>.
 - a. Accessory Tiles: [Ridge] [ridge vent] [ridge end] [hip and hip starter] [header course] [L-shaped rake edge] [roll rake edge] [starter] [end band] [terminal] [eave closure] [and] [top fixture] <Insert accessory> units.
 - 3. Low-Profile Shape: Type II, [French interlocking] <Insert shape>.
 - a. Accessory Tiles: [Ridge] [ridge vent] [ridge end] [hip and hip starter] [header course] [L-shaped rake edge] [roll rake edge] [starter] [end band] [terminal] [eave closure] [and] [top fixture] <Insert accessory> units.
 - 4. Flat Shape: Type III, [flat shingle] [flat interlocking] <Insert shape>.
 - a. Accessory Tiles: [Ridge and closed ridge end] [hip and hip starter] [header course] [L-shaped rake edge] [starter] [end band] [and] [terminal] <Insert accessory> units.
 - 5. Size: <Insert length and width dimensions>.
 - a. Provide clay roof tiles of diminishing widths for circular bays or round towers.
 - 6. Finish and Texture: [Matte, smooth] [Matte, striated] [Glazed, smooth] <Insert finish and texture>.
 - 7. Color: [Terra cotta] [Brown] [Red] [Blended red] [Buff] <Insert description>.

2.04 UNDERLAYMENT MATERIALS

- A. Felt: [ASTM D226/D226M Type II, asphalt saturated] [ASTM D4869/D4869M Type IV, asphalt saturated] [ASTM D2626/D2626M, asphalt saturated and coated, mineral-granule surfaced on weather (top) side], unperforated.
- B. Asphalt Roll-Roofing: ASTM D6380/D6380M, Class M, Type II, asphalt-saturated and -coated organic felt; mineral-granule surfaced on weather (top) side.
- C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended, in writing, by manufacturer for use under roof tile; and evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Polymer-Modified Bitumen Sheet: Styrene-butadiene-styrene- (SBS) modified asphalt, glass-fiber-mat-reinforced sheet; minimum [55-mil] [40-mil] <Insert dimension> nominal thickness; recommended in writing by manufacturer and acceptable to authorities having jurisdiction for use as underlayment in tile steep-slope roofing systems; and designed for mechanical fastening or adhesive attachment using roofing asphalt or cold-applied adhesive.
 - 1. <Insert testing requirements>.
- E. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, minimum [55-mil-] [50-mil-] [40-mil-] <Insert dimension> thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required. [Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.]
 - 1. Top Surface: [Sand] [Granule] [Textured polymer film] [Polyester].
- F. Self-Adhering, Polymer-Modified Bitumen Sheet, High Temperature: ASTM D1970/D1970M, minimum [55-mil-] [50-mil-] [40-mil-] <Insert thickness> thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required. [Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.]
 - 1. Thermal Stability: Stable after testing at 240 deg F in accordance with ASTM D1970/D1970M.
 - 2. Top Surface: [Granule] [Textured polymer film] [Polyester].

2.05 RIDGE VENTS

- A. Rigid-Plastic Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under ridge tiles.
 - 1. Minimum Net Free Area: <Insert area>.
 - 2. Width: <Insert dimension>.
 - 3. Thickness: <Insert dimension>.
- B. Flexible Ridge Vent: Manufacturer's standard roll-form ridge vent that protects against driven rain and snow and is recommended in writing by manufacturer for installation with roof tile indicated.

1. Width: <Insert dimension>.
2. Features: [Butyl adhesive strips at sides] [Corrugated aluminum strips at sides].

2.06 ACCESSORIES

- A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.
- B. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.
- C. Elastomeric Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant of class and use classifications required to seal joints in clay-tile roofing and remain watertight; recommended in writing by manufacturer for applications indicated.
- D. Roofing Asphalt: ASTM D312/D312M Type IV.
- E. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.
- F. Mortar: ASTM C270, Type M, [natural color] [with ASTM C979/C979M, pigmented mortar matching the color of clay roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar].
- G. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended in writing for application by clay-roof-tile manufacturer.
- H. Eave Closure: Manufacturer's standard [EPDM] [copper] [stainless steel] [galvanized-steel] [aluminum, mill finish] <Insert material> eave closure formed to shape of clay roof tiles.
- I. Wood Nailers: Comply with requirements for pressure-preservative-treated wood in Section 06 10 53 " Miscellaneous Rough Carpentry."
- J. Mesh Fabric: 18-by-14 mesh of PVC-coated, glass-fiber thread.

2.07 FASTENERS

- A. Roofing Nails: ASTM F1667, hot-dip galvanized-steel, 0.120-inch diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum 3/8-inch-diameter head; of sufficient length to penetrate 3/4 inch into substrate or extend at least 1/8 inch through thickness of the sheathing, whichever is less.
 1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- B. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, 1-inch-minimum diameter.
 1. Provide with minimum 0.0134-inch-thick metal cap, 0.010-inch-thick power-driven metal cap, or 0.035-inch-thick plastic cap; and with minimum 0.083-inch-thick ring shank or 0.091-inch-thick smooth shank of length to penetrate at least 3/4 inch into roof sheathing or to penetrate through roof sheathing less than 3/4 inch thick.

- C. Nails for Wood Nailers: ASTM F1667; hot-dip galvanized-steel, common or box, steel wire, flat head, and smooth shank.
- D. Wire Ties: [Copper] [Brass] [Stainless steel], 0.083-inch-minimum diameter.
- E. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed 6 inches apart, minimum [0.101-inch-diameter copper wire and 0.064-inch-diameter copper tie wires] [0.090-inch-diameter stainless steel wire and 0.063-inch-diameter stainless steel tie wires] [0.105-inch-diameter galvanized-steel wire and 0.063-inch-diameter galvanized-steel tie wires] <Insert requirements>, with matching-metal folding clip anchors.
- F. Single-Line, Wire-Tie System: Interconnecting eave-to-ridge system, minimum [0.101-inch-diameter copper] [0.090-inch-diameter stainless steel] [0.105-inch-diameter galvanized-steel] <Insert requirements> wire, preformed to accommodate clay roof tile type and application indicated.
- G. Hook Nails: One-piece wind lock and clay-roof-tile fastener system, minimum [0.135-inch-diameter brass] [0.135-inch-diameter copper] [0.120-inch-diameter stainless steel] [0.120-inch-diameter galvanized-steel] <Insert requirements> wire, for direct deck nailing.
- H. Tile Locks: [Brass] [Copper] [Stainless steel] [Hot-dip galvanized-steel], nominal 0.1-inch-diameter wire device designed to secure butt edges of overlaid clay roof tiles.
- I. Storm Clips: [Brass, minimum 0.048-by-1/2-inch] [Stainless steel, minimum 0.048-by-1/2-inch] [Hot-dip galvanized-steel, minimum 0.048-by-1/2-inch] <Insert requirements> strap-type, L-shaped retainer clips designed to secure side edges of clay roof tiles. Provide with two fastener holes in base flange.

2.08 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 1. Sheet Metal: [Copper] [Stainless steel] [Zinc-tin alloy coated copper] [Anodized aluminum] [Aluminum, mill finished] <Insert requirements>.
- B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.
 - 1. Apron Flashings: Fabricate with lower flange extending a minimum of [4 inches] [6 inches] <Insert dimension> over and [4 inches] <Insert dimension> beyond each side of downslope tile roofing and [6 inches] <Insert dimension> up the vertical surface.
 - 2. Step Flashings: Fabricate with a headlap of 4 inches and a minimum extension of [4 inches] [5 inches] <Insert dimension> both horizontally and vertically.
 - 3. Channel Flashings: Fabricate with vertical surface extending a minimum of [4 inches] [5 inches] <Insert dimension> above the clay roof tile and [4 inches] [6 inches] <Insert dimension> beneath the tile roofing, with a [1-inch-] <Insert dimension> high vertical return to form a runoff channel.

4. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and **[6 inches]** **<Insert dimension>** beneath the tile roofing, with a **[1-inch-]** **<Insert dimension>** high vertical return to form a runoff channel.
 5. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of **[24 inches]** **<Insert dimension>** beneath upslope tile roofing, **[6 inches]** **<Insert dimension>** beyond each side of **[chimney]** **[skylight]**, and **[6 inches]** **<Insert dimension>** above the roof plane.
 6. Counterflashings: Fabricate to cover **[4 inches]** **<Insert dimension>** of base flashing measured vertically; and in lengths required so that no step exceeds **[8 inches]** **<Insert dimension>** and overall length is no more than **[10 feet]** **<Insert dimension>**.
 - a. Provide metal **[reglets]** **[receivers]** for installation.
 7. Valley Flashings: Fabricate from metal sheet not less than **[24 inches]** **<Insert dimension>** wide in lengths not exceeding **[10 feet]** **<Insert dimension>**, with **[1-inch-]** **<Insert dimension>** high, inverted-V profile water diverter at center of valley and equal flange widths of not less than **[11 inches]** **<Insert dimension>**.
 - a. Hem flange edges for fastening with metal cleats.
 8. Drip Edges: Fabricate in lengths not exceeding **[10 feet]** **<Insert dimension>**, with minimum 2-inch roof-deck flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.
- C. Sheet Metal Ridge Vent: Fabricate from 16-oz./sq. ft.- thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net free ventilation area of 2.65 sq. in./ft..
- D. Vent-Pipe Flashings: ASTM B749, Type L51121, at least 1/16 inch thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches from pipe onto roof.
- E. **<Insert snow-guard requirements>**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through roofing.
 3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF CLAY ROOF TILES

- A. Install clay roof tiles in accordance with manufacturer's written instructions and recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" unless more stringent requirements are specified in this Section or indicated on Drawings.
 - 1. Install to resist wind forces resulting from design wind speeds indicated on Drawings.
 - 2. Maintain uniform exposure and coursing of clay roof tiles throughout roof.
 - 3. Extend tiles 2 inches over eave fasciae.
 - 4. Nail Fastening: Drive nails to clear the clay roof tile so the tile hangs from the nail and is not drawn up.
 - a. Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.
 - 5. Wire-Tie Fastening: Install wire-tie systems and fasten clay roof tiles in accordance with manufacturer's written instructions.
 - 6. Mortar Setting: Install clay roof tiles in accordance with manufacturer's written instructions and acceptance criteria of authorities having jurisdiction.
 - 7. Foam-Adhesive Setting: Install clay roof tiles in accordance with adhesive and tile manufacturers' written instructions and acceptance criteria of authorities having jurisdiction.
 - 8. Storm Clips: Install to capture edges of longitudinal sides of clay roof tiles and securely fasten to roof deck.
 - 9. Tile Locks: Install to support and lock overlying tile butts to underlying tiles.
 - 10. Cut and fit clay roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
 - 11. Install clay roof tiles with color blend approved by Architect.
- B. Flat-Shingle Clay-Roof-Tile Installation:
 - 1. Maintain 2-inch headlap between succeeding courses of clay roof tiles.
 - 2. Offset joints by half the clay-roof-tile width in succeeding courses.
 - 3. Extend clay roof tiles 1 inch over fasciae at rakes.
 - 4. Install ridge tiles in **[V-ridge] [saddle] [mitered]** configuration with laps facing away from prevailing wind. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.
 - a. Close voids where ridge tiles meet clay roof tiles with **[ridge closure] [mortar struck with face of ridge cover]** tiles.
 - 5. Install hip tiles in **[V-ridge] [saddle] [mitered]** configuration. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.
 - a. Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.

C. Flat Interlocking Clay-Roof-Tile Installation:

1. Provide minimum 3-inch lap between succeeding courses of clay roof tiles.
2. Offset joints by half the clay-roof-tile width in succeeding courses.
3. Install L-shaped rake tiles.
4. Install ridge tiles in **[V-ridge] [saddle] [mitered]** configuration with laps facing away from prevailing wind. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.
 - a. Close voids where ridge tiles meet clay roof tiles with **[ridge closure] [mortar struck with face of ridge cover]** tiles.
5. Install hip tiles in **[V-ridge] [saddle] [mitered]** configuration. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.
 - a. Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.

D. Low-Profile, Interlocking Clay-Roof-Tile Installation:

1. Provide minimum 3-inch lap between succeeding courses of clay roof tiles.
2. Install rake tiles indicated.
3. Install ridge tiles with laps facing away from prevailing wind. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.

E. High-Profile Clay-Roof-Tile Installation:

1. Install **[tile] [sheet metal] [EPDM]** eave closure.
2. Provide minimum 3-inch lap between succeeding courses of clay roof tiles.
3. Install rake tiles indicated.
4. Install ridge tiles with laps facing away from prevailing wind. Seal laps with **[asphalt roofing cement] [butyl sealant] [elastomeric sealant]**.

F. Open Valleys: Cut clay roof tiles at open valleys to form straight lines. **[Maintain uniform width of exposed open valley] [Widen exposed portion of open valley 1/8 inch in 12 inches]** from highest to lowest point.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

G. Closed Valleys: Cut clay roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap of **[1/2 to 3/4 inch] [3/4 to 1 inch]** <Insert dimension> on either side of water diverter at valley centerline.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

H. Remove and replace damaged or broken clay roof tiles.

3.03 INSTALLATION OF UNDERLAYMENT MATERIALS

- A. Comply with clay-roof-tile and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.
1. Cover **[ridge]** **[hip]** wood nailers with underlayment strips.
- B. Felt: Install parallel with and starting at eaves and fasten with underlayment nails.
1. Single-Layer Installation: Install on roof deck.
 - a. Lap sides a minimum of **[2 inches]** **[4 inches]** over underlying course.
 - b. Lap ends a minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.
 - a. Lap sides a minimum of **[2 inches]** **[4 inches]** over underlying course.
 - b. Lap ends a minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 3. Double-Layer Installation: Install on roof deck.
 - a. Install a 19-inch-wide starter course at eaves and completely cover with a 36-inch-wide second course.
 - b. Install succeeding 36-inch-wide courses lapping previous courses 19 inches in shingle fashion.
 - c. Lap ends a minimum of 6 inches.
 - d. Stagger end laps between succeeding courses at least 72 inches.
 - e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply **[over entire roof]** **[at locations indicated on Drawings]**.
 4. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
 5. Install felt over areas protected by self-adhering, polymer-modified bitumen sheet.
 6. Terminate felt **[flush]** **[extended up not less than 4 inches]** **<Insert requirements>** against sidewalls, curbs, chimneys, and other roof projections.
- C. Asphalt Roll-Roofing: Install parallel with and starting at eaves.
1. Single-Layer Installation: Install on roof deck.
 - a. Lap sides a minimum of **[2 inches]** **[4 inches]** over underlying course.
 - b. Lap ends a minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. Fasten with underlayment nails.
 2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.
 - a. Lap sides a minimum of **[2 inches]** **[4 inches]** over underlying course.

- b. Lap ends a minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. **[Fasten with underlayment nails] [Adhere to anchor layer in solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature] [Adhere to anchor layer in uniform coating of cold-applied adhesive] [Adhere to anchor layer in uniform coating of asphalt roofing cement].**
3. Double-Layer Installation: Install on roof deck.
- a. Install a 19-inch-wide starter course at eaves and completely cover with a 36-inch-wide second course.
 - b. Install succeeding 36-inch-wide courses lapping previous courses 19 inches in shingle fashion.
 - c. Lap ends a minimum of 6 inches.
 - d. Stagger end laps between succeeding courses at least 72 inches.
 - e. Fasten with underlayment nails.
 - f. Apply a continuous layer of asphalt roofing cement over starter course and on roll-roofing surface to be concealed by succeeding courses as each roll-roofing course is installed. Apply **[over entire roof] [at locations indicated on Drawings].**
4. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
5. Install roll roofing over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate roll roofing **[flush] [extended up not less than 4 inches] <Insert requirements>** against sidewalls, curbs, chimneys, and other roof projections.
- D. Synthetic-Underlayment Top Layer: Install in accordance with manufacturer's written installation instructions and as second layer over anchor-layer underlayment.
1. Completely cover anchor-layer underlayment and install parallel with and starting at the eaves, with side laps offset halfway between side laps of underlying anchor layer.
 2. Lap sides and ends as recommended in writing by manufacturer, but not less than **[2 inches] [4 inches]** for side laps and 6 inches for end laps.
 3. Stagger end laps from anchor-layer end laps and between succeeding top courses at interval recommended in writing by manufacturer, but not less than 72 inches.
 4. Fasten with underlayment nails.
 5. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
- E. Polymer-Modified Bitumen Sheet: Install parallel with and starting at eaves.
1. Single- or Anchor-Layer Installation: Install on roof deck.
 - a. Lap sides a minimum of **[2 inches] [4 inches]** over underlying course.
 - b. Lap ends a minimum of 6 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. Fasten with underlayment nails.
 2. Top-Layer Installation: Install as a second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

- a. Lap sides a minimum of **[2 inches] [4 inches]**.
 - b. Lap ends a minimum of 6 inches.
 - c. Stagger end laps from anchor-layer end laps and between succeeding top-layer courses at least 72 inches.
 - d. **[Fasten with underlayment nails] [Adhere to anchor layer in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature] [Adhere to anchor layer in uniform coating of cold-applied adhesive].**
3. Double-Layer Installation: Install on roof deck in overlapping layers with a half-width plus 1-inch-wide starter course at eaves completely covered by full-width second course.
 - a. Install succeeding courses lapping previous courses by a half-width plus 1 inch in shingle fashion.
 - b. Lap ends a minimum of 6 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. Fasten with underlayment nails.
 4. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
 5. Install sheets over areas protected by self-adhering, polymer-modified bitumen sheet.
 6. Terminate sheets **[flush] [extended up not less than 4 inches] <Insert requirements>** against sidewalls, curbs, chimneys, and other roof projections.
- F. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free.
1. Comply with low-temperature installation restrictions of underlayment manufacturer.
 2. Install lapped in direction that sheds water.
 3. Lap sides not less than 4 inches.
 4. Lap ends not less than 6 inches, staggered 24 inches between succeeding courses.
 5. Roll laps with roller.
 6. Prime concrete, masonry, and metal surfaces to receive self-adhering, polymer-modified bitumen sheet.
 7. Single-Layer Installation: Install over entire roof deck.
 8. Top-Layer Installation: Install as second layer over anchor-layer underlayment.
 - a. Completely cover anchor-layer underlayment.
 - b. Offset side laps halfway between side laps of underlying anchor layer and offset end laps from those of underlying anchor layer at least 72 inches.
 9. Water and Ice-Dam Protection Installation: Install on roof deck where indicated **[below] [on Drawings]**.
 - a. Eaves: Extend from edges of eaves **[24 inches] [36 inches] <Insert dimension>** beyond interior face of exterior wall.
 - b. Rakes: Extend from edges of rakes **[24 inches] [36 inches] <Insert dimension>** beyond interior face of exterior wall.
 - c. Valleys: Extend from lowest to highest point **[18 inches] <Insert dimension>** on each side of centerline.
 - d. Hips: Extend **[18 inches] <Insert dimension>** on each side.

- e. Ridges: Extend **[36 inches]** <Insert dimension> on each side [without obstructing continuous ridge vent slot].
 - f. Sidewalls: Extend **[18 inches]** <Insert dimension> beyond sidewalls and return vertically against sidewalls not less than **[4 inches]** <Insert dimension>.
 - g. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend **[18 inches]** <Insert dimension> beyond penetrating elements and return vertically against penetrating elements not less than **[4 inches]** <Insert dimension>.
 - h. Roof-Slope Transitions: Extend **[18 inches]** <Insert dimension> on each roof slope.
10. Cover underlayment within seven days.
- G. Valley Underlayment: Install one layer of 36-inch-wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.
- 1. Use [same underlayment as installed on field of roof] <Insert requirements>.
 - 2. Lap ends at least 12 inches in direction that sheds water, and seal with asphalt roofing cement.
 - 3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
 - 4. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.04 INSTALLATION OF RIDGE VENTS

- A. Rigid-Plastic Ridge Vents: Install continuous ridge vents over clay roof tiles in accordance with manufacturer's written instructions. Fasten with nails of sufficient length to penetrate substrate.
- B. Flexible Ridge Vent: Install continuous-roll ridge vents over clay roof tiles in accordance with manufacturer's written instructions.

3.05 INSTALLATION OF METAL FLASHING AND TRIM

- A. Install metal flashings and other sheet metal to comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 1. Install in accordance with clay-roof-tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."
- B. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.
- C. Step Flashings: Install with a headlap of 4 inches and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.
- D. Cricket and Backer Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.
- E. Channel Flashings: Install over underlayment materials and fasten to roof deck.
- F. Rake Pan Flashings: Install over underlayment materials and fasten to roof deck.

- G. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of 4 inches secured in a waterproof manner.
1. Install in reglets or receivers.
- H. Valley Flashings: Install centered in valleys, lapping ends at least [8 inches] <Insert dimension> in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.
1. Secure hemmed flange edges into metal cleats spaced [12 inches] [24 inches] <Insert dimension> apart and fastened to roof deck.
 2. Adhere minimum [9-inch-] <Insert dimension> wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to [underlying self-adhering, polymer-modified bitumen sheet] <Insert requirements>. Place strips parallel to and over flanges so that they will be just concealed by installed tile.
 3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.
- I. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.
- J. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.
- K. Sheet Metal Ridge Vents: Install centered on and mechanically fasten to wood ridge. Adhere each side to clay roof tile with elastomeric sealant.
1. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.
- L. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.

3.06 INSTALLATION OF WOOD NAILERS

- A. Install wood nailers securely fastened to roof deck at the following locations:
1. Hips.
 2. Ridges.
 3. Rakes.
- B. Install beveled wood-cant nailers at eaves and securely fasten to roof deck.
- C. Install nominal 1-by-2-inch wood-batten nailers horizontally [over 1/2-inch-high, pressure-preservative-treated wood lath strips] [in 48-inch lengths with ends separated by 1/2 inch], at spacing required by clay-roof-tile manufacturer, and securely fasten to roof deck.
1. Install nominal 1-by-2-inch wood counter battens vertically spaced [24 inches] <Insert dimension> apart and securely fasten to roof deck.

3.07 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS <Insert name> of <Insert address>, herein called the "Roofing Installer," has performed roofing and associated work ("the work") on the following project:
1. Owner: <Insert name of Owner>.
 2. Owner Address: <Insert address>.
 3. Building Name/Type: <Insert information>.

4. Building Address: **<Insert address>**.
 5. Area of the Work: <Insert information>.
 6. Acceptance Date: **<Insert date>**.
 7. Warranty Period: **<Insert time>**.
 8. Expiration Date: **<Insert date>**.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant the work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of the work as are necessary to correct faulty and defective work and as are necessary to maintain the work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to the work and other parts of the building, and to building contents, caused by:
 - a. Lightning;
 - b. Peak gust wind speed exceeding **<Insert mph>**;
 - c. Fire;
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. Faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. Vapor condensation on bottom of roofing; and
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 2. When the work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to the work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the work.
 4. During Warranty Period, if Owner allows alteration of the work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of the alterations, but only to the extent the alterations affect the work covered by this Warranty. If Owner engages Roofing Installer to perform the alterations, Warranty shall not become null and void unless Roofing Installer, before starting the alterations, notified Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty shall become null and void on date of the change, but only to the extent the change affects the work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect the work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on the work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of the work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature>.
2. Name: <Insert name>.
3. Title: <Insert title>.

END OF SECTION

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SECTION 07 41 13

STANDING-SEAM METAL ROOF PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes standing-seam metal roof panels.
- B. Related Sections:
 - 1. Section 07 42 93 "Soffit Panels" for metal panels used in horizontal soffit applications.
 - 2. Section 07 72 53 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review structural loading limitations of **[deck] [purlins and rafters]** during and after roofing.
 - 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 - 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 8. Review temporary protection requirements for metal panel systems during and after installation.
 - 9. Review procedures for repair of metal panels damaged after installation.
- B. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
- B. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

1.04 SHOP DRAWINGS:

- A. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
- B. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples
 - 1. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
 - 2. Include similar Samples of trim and accessories involving color selection.
 - 3. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 4. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.
- D. Qualification Data: For Installer.
- E. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Sample Warranties: For special warranties.
- H. Closeout submittals:
 - 1. Maintenance Data: For metal panels to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
- D. Retain first subparagraph below for large-scale mockup. Indicate portion of roof represented by mockup on Drawings or draw mockup as separate element.

- E. Build mockup of typical roof area and eave [, **including fascia,**] [**and soffit**] as shown on Drawings; approximately [**48 inches**] [**12 feet**] <Insert dimension> square by full thickness, including attachments [, **underlayment,**] and accessories.
 - F. Build mockups for typical roof area only, including accessories.
 - G. Size: [**12 feet** long by **6 feet**] <Insert dimension>.
 - H. [**Each type of exposed seam and seam termination**] <Insert mockup item>.
 - I. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - J. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
 - B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
 - C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- 1.07 FIELD CONDITIONS
- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.
- 1.08 COORDINATION
- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
 - B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
- 1.09 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.

- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.
 - 1. Solar reflective index (SRI): Not less than 29 per ASTM E1980.
 - 2. Reflectance and Emissivity:
 - a. Solar Reflectance: Not less than 0.25 per ASTM test methods C1549 or E1918, or CRRC-1 Method #1.
 - 3. Thermal Emissivity: Not less than 0.75 per ASTM C1371.
- B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
 - 1. Three-year, aged solar reflectance of not less than and emissivity of not less than 0.75.
- C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
 - 4. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 15.0 lbf/sq. ft.

- E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- H. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

2.02 STANDING-SEAM METAL ROOF PANELS

- A. Formed with integral ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and lapping and interconnecting side edges of adjacent panels.
 - 1. System based on AEP Span, a Division of ASC Profiles, Inc.; Preformed Metal Standing Seam Roofing – SpanSeam (SPS2216), or equal.
 - 2. Acceptable manufacturer's meeting these requirements are:
 - a. Berridge Manufacturing Company.
 - b. SLR Standing Seam Roof Panels by Morin, aa Kingspan Group Company.
 - c. Or equal.
 - 3.
 - 4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.022 inch.
 - 5. Clips: Two-piece floating to accommodate thermal movement.
 - a. Material: 0.028-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 - 6. Panel Coverage: 16 inches.

7. Panel Height: 2.0 inches.
- B. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at 300 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. System based on Grace Ultra by GCP Applied Technologies, or equal.
 - C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
 - D. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
 - E. Retain panel accessories, flashing, and trim as required and coordinate with those specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - F. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - G. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
 - H. Panel Fasteners: Self-tapping screws designed to withstand design loads.
 - I. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.03 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.04 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. DuraTech® 5000: Polyvinylidene Fluoride, full 70 percent Kynar 500® or Hylar 5000®, consisting of a baked-on 0.15-0.20 mil corrosion resistant primer and a baked-on 0.70-0.80 mil finish coat with a specular gloss of 8 to 15 when tested in accordance with ASTM D523 at 60 degrees with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
- B. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
- C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
- D. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- E. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
- B. Apply over the roof area indicated below:
1. Roof perimeter for a distance up from eaves of **[24 inches] [36 inches] <Insert dimension>** beyond interior wall line.
 2. Valleys, from lowest point to highest point, for a distance on each side of **[18 inches] <Insert dimension>**. Overlap ends of sheets not less than 6 inches.
 3. Rake edges for a distance of **[18 inches] <Insert dimension>**.
 4. Hips and ridges for a distance on each side of **[12 inches] <Insert dimension>**.
 5. Roof-to-wall intersections for a distance from wall of **[18 inches] <Insert dimension>**.
 6. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of **[18 inches] <Insert dimension>**.
- C. Felt Underlayment: Apply at locations indicated **[below] [on Drawings]**, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.
1. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.
- D. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- E. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3.04 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Shim or otherwise plumb substrates receiving metal panels.
 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal panel work proceeds.

6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 5. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
 6. Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.
 7. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - a. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

- F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- G. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- H. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
 2. Connect downspouts to underground drainage system indicated.
- I. Roof Curbs: Install flashing around bases where they meet metal roof panels.
- J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.05 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 42 13.13

FORMED METAL WALL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes open-joint, preformed aluminum wall panels, soffit and roof panels, sunscreens and canopies, their support system, special shapes, and all other panels elements for the building.
- B. Related requirements:
 - 1. Division 05 for steel studs in exterior walls.
 - 2. Division 07 for the following:
 - a. Insulation.
 - b. Other flashing and sheet metal.
 - c. Air/water barrier.
 - d. Sealants.
 - 3. Division 08 for curtain wall.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
 - 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 7. Review temporary protection requirements for metal panel assembly during and after installation.
 - 8. Review of procedures for repair of metal panels damaged after installation.
 - 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

B. Coordination

1. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.03 SUBMITTALS

A. Data:

1. Manufacturer Product Data sheet or equivalent printed literature indicating product information for panel attachment system, setting accessories and other related materials.
2. Data shall substantiate that the materials comply with the specified requirements.

B. Shop Drawings: Dimensioned Shop Drawings for the preformed wall panel system, including design and detailing of the panel support framing elements and their attachment to the structural frame. Coordinate drawings and their submittal with the curtain wall system and other exterior wall components.

1. Show the panel layout on each plane, support framing system, panel attachment members, secondary water control, jointing, dimensions, sizes and locations of cut-outs, relation to work of other trades, and other pertinent data and information.
2. Indicate and dimension adjoining, abutting and penetrating work to be performed by other trades.
3. Number each panel to correspond to the markings shown on the fabrication or shop drawings. Mark the identification number on the back of each panel.
4. The Drawings and calculations shall bear the seal of a California-registered professional engineer. The engineer shall also perform and submit structural calculations to document all panel conditions.

C. Samples:

1. Prior to fabrication, submit 12-inch square preliminary Samples panels showing corners, special shapes, or other conditions and finishes, as may be required by the Architect, at the jobsite for review and approval.
2. Samples will serve as the control for limiting acceptable range of appearance.

D. Data:

1. Manufacturer Product Data sheet or equivalent printed literature indicating product information for panel attachment system, setting accessories maintenance and other related materials.
2. Data shall substantiate that the materials comply with the specified requirements.

E. Closeout: Manufacturer instructions for care, repair and replacement procedures, and Samples showing repaired panels.

1.04 QUALITY ASSURANCE

A. Fabricator/installer qualifications:

1. Single firm with a minimum of 5 years successful experience in the fabrication and erection of panel systems of similar sizes, shapes and finishes required for this Project, and which has ample production facilities to produce, furnish and supply the panels as required for installation without delay to the Work.

2. Firm must be regularly engaged in the engineering, fabrication, finishing and installation, of similar work.
- B. Mockup: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery:

1. After fabrication, protect panels with strippable plastic film.
2. Deliver panels to ensure that there will be no damage or staining.
3. Deliver other materials, except bulk materials, in manufacturer's unopened containers with name, brand, type, grade and color fully indicated thereon. Store bulk materials as required to avoid any deleterious effects of weather, soiling or contamination.
4. Delivered items shall be properly boxed or crated. Mark containers with installation location, fabrication/piece numbers, shop drawings reference, etc., as applicable.

B. Storage:

1. Store above grade on suitable surfaces using polyethylene film to separate panels from supporting or protecting members.
2. Protect from weather, soiling and damage of every kind.
3. Crate panels to prevent accumulation of moisture between panels.

1.06 WARRANTY

A. Warrant that panels and their support system will meet the specified performance criteria specified and will be free from defects in materials and workmanship for 2 years after Substantial Completion, except where longer warranties are specified below.

1. Certify in writing that installed work is in accordance with the Contract Documents and authorized alterations and/or additions thereto and that, should defect develop during the warranty period due to improper workmanship or materials installed as a part of this Section, such defects will upon written request, be repaired or replaced at no additional cost to the Owner.
2. If exploratory work is required to determine the cause of the defects, the cost of such work shall be borne by the Contractor when his work is found to be at fault.
3. Further warrant the Owner in writing that wall panels will not evidence delamination of any type for 10 years after Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: [20] [10] [5] <Insert number> years from date of Substantial Completion.

- C. The warranty, the enforcement or lack of enforcement thereof, shall not deprive the Owner of other actions, rights or remedies available to him. Warranty shall be in form approved by Owner.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA:

- A. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: [1.57 lbf/sq. ft. (75 Pa)] [6.24 lbf/sq. ft. (300 Pa)].
- B. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: [2.86 lbf/sq. ft. (137 Pa)] [6.24 lbf/sq. ft. (300 Pa)].
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): [120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces] <Insert temperature range>.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- E. Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening or fracturing of attachments or components of system are not permitted in the installed work.
- F. Design system so panels can be removed without removing or disrupting adjacent panels or materials.

2.02 EXPOSED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.

2.03 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners [and factory-applied sealant] in side laps. Include accessories required for weathertight installation.

2.04 METAL LINER PANELS

- A. Provide factory-formed metal liner panels designed for interior side walls and field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for a complete installation.

2.05 MATERIALS

- A. Aluminum Sheet: Coil-coated sheet, ASTM B209 (ASTM B209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
- B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
- C. Clips, pins and fasteners: 300 series stainless steel. Use for attachment to substructure of sizes required to meet performance criteria. Secure clips in the manufacturer's facility to the greatest degree possible. Pop rivet attachment of clips and accessories will not be accepted.
- D. Flashings, closure strips or metal trim: Of materials to match that of panel sheets in thickness as required to fulfill performance criteria.
- E. Back pans on panels: Of sizes and minimum gages required to fulfill performance requirements.
- F. Metal panel support system:
 - 1. Stud and joist framing members: As specified in Section 05 40 00.
 - 2. Aluminum extrusion panel retention members, clips, angles or panel hangers: Design to fulfill performance criteria specified.
 - 3. Structural steel shapes: ASTM A 36.
 - 4. Steel plates: ASTM A 283, Grade C.
 - 5. Air/water barrier: As specified in Section 07 27 00.
- G. Miscellaneous materials:
 - 1. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - a. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 - b. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - c. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

2. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
3. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
4. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - b. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.06 FABRICATION

- A. Manufacture panels under controlled environment in fabricator's plant in conformance with accepted shop drawings and calculations so tolerances, as stated herein, are not exceeded. Field fabrication of panels is not permitted.
- B. Weld inside surfaces of seams, such as the panel returns at corners, to prevent intrusion of water.
- C. Clean surfaces in compliance with the sealant manufacturer's recommendations, and apply sealant to inside surfaces of seams, such as the panel returns at corners, to prevent intrusion of water.
- D. Grind and polish exposed welds to match adjacent surface finish and to be invisible in the finish work.
- E. Install back pans as required sealing all perimeter edges.
- F. Flatness of panels defined:
 1. Ensure exposed metal panels including exposed flashing components have a visual flatness acceptable to Architect and in such manner that slope of any surface at any point does not exceed 0.5 percent from nominal plane of surface when measured in any direction at one inch intervals when ambient temperature is at 72 deg F and under any combination of performance conditions. This requirement is also applicable to conditions and jointing of components in same plane and to transition from one component to another or similar component in same plane.
 2. Short length distortion ripples, edge distortions, "oil-canning", "telegraphing of fasteners" and like will not be permitted. Make provisions to allow for differential thermal expansion between stiffeners, recessed slots and exposed metal of curtain wall system to take place without noise and without buckling of surface.
 3. Dimensional tolerances of outer dimensions of panels: +/-1/32-inch in 48 inches measured at any point.

G. Fabrication tolerances:

1. Panel bow: Maximum 0.2 percent of width or length, whichever is greater.
2. Width or length: Plus 0.064 to 48-inch; Plus 0.032 to 144-inch
3. Thickness: Plus 0.008-inch.
4. Squareness: 0.1875-inch difference between diagonals.
5. Camber: 0.062-inch maximum.
6. Radius of exterior bent corners: 1/16-inch maximum.

2.07 FINISHING

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
2. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
3. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
4. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
5. FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
7. Finish in "Concealed Finish" Subparagraph below is frequently used as a factory finish for interior surfaces.

8. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

D. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
7. Exposed Anodized Finish:
 - a. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
8. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine structure that will support the metal panel framing system. Verify elevation, tolerances, embedments, offset lines, and other conditions, which would affect the satisfactory installation and performance of the panels.
- B. Correct unsuitable conditions before proceeding with erection.

3.02 PREPARATION

- A. Examine framework to receive panels. Make certain framework is secure and properly aligned and prepared to receive panels.
- B. Do not begin installation of panels until Architect has accepted secondary air/ water barrier.
- C. Prepare surfaces to be in contact with panels and panel surfaces in compliance with materials manufacturers' recommendations and those of panel fabricator prior to installation of panels to framework.

3.03 INSTALLATION

- A. Install panels and panel support members in compliance with approved shop drawings, calculations, and fabricator's published instructions. Install panels so that in their final location and position joints are uniform, perfectly aligned, with flush joints, and panels are not twisted out of plane. Adjust work to conform to the following tolerances (maximum variations).
 - 1. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 2. Install screw fasteners in predrilled holes.
 - 3. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 4. Install flashing and trim as metal panel work proceeds.
 - 5. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 6. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
 - 8. Face width of joints: Plus 1/32-inch.
 - 9. Joint taper: 1/100-inch/ft length, with a maximum length of tapering in one direction of 6 feet.
 - 10. Jog in alignment of edge: Plus 1/16-inch.
 - 11. Rough opening dimension: Plus 1/16-inch at head, Plus 1/16-inch at sill, and Plus 1/16-inch at jamb.
 - 12. Deviation from plumb, 1/16-inch maximum per one story height and a maximum of 1/8-inch in a 45 feet. run.
 - 13. Deviation from horizontal: 1/8-inch maximum in a 30 feet. run.
- B. Fasteners
 - 1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Liner Panels: Install panels on [exterior side of girts, with girts exposed to the interior] [interior side of girts with flush appearance on the inside].
- D. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- E. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- 3.04 SEALANTS
- A. Comply with the requirements of Section 07 92 00 for sealants, backer rods, and their installation.
- 3.05 FIELD QUALITY CONTROL
- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - B. Water-Spray Test: After installation, test area of assembly [shown on Drawings] [as directed by Architect] <Insert area> for water penetration according to AAMA 501.2.
 - C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
 - D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
 - E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
 - F. Prepare test and inspection reports.
- 3.06 CLEANING AND PROTECTING
- A. Leave protective coatings or films on panels in place as long as possible where doing so will not produce discoloration or other undesirable visual defects.
 - B. Remove protective coatings or films when, and in the manner, recommended by materials manufacturers published instructions.
 - C. Clean panels in accordance with material manufacturers' published recommendations.
 - D. Protect panels from damage. Repair or replace any damaged panels to Architect's satisfaction.

1. Carefully remove rejected panels and replace with new panels without delay and without cost to the Collage.
2. Remove panel or panels damaged in the removal of defective or rejected panels and replace with new panels.

END OF SECTION

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SECTION 07 42 13.23

METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes panel system and the following components:
 - 1. Metal composite material panels with mounting system.
 - 2. Panel mounting system including anchors, shims, furring, fasteners, gaskets and sealants, related flashing adapters, and masking (as required) for a complete watertight installation.
- B. Related requirements: Division 07 for other sheet metalwork.

1.02 DEFINITIONS

- A. MCM: Metal Composite Material.
- B. Panel:
 - 1. Two sheets of aluminum sandwiching a solid core of extruded thermoplastic material formed in a continuous process with no glues or adhesives between dissimilar materials.
 - 2. The core material shall be free of voids and shall not contain foamed insulation material.
 - 3. Products laminated sheet by sheet in a batch process using glues or adhesives between materials are not acceptable.

1.03 SUBMITTALS

- A. Data: Manufacturer including product specifications, standard details, certified product test results, installation instructions, and general recommendations, as applicable to materials and finishes for each component and for total panel system.
- B. Shop Drawings: Dimensioned Shop Drawings showing materials, gages, methods of fabrication and assembly, joints, finishes and all other pertinent data.
 - 1. Show panel layout, details edge conditions, joints, corners, panel profiles, supports, anchorages, trim, flashings, closures, and special details.
 - 2. Distinguish between factory and field assembled work.
- C. Samples: 12-inch long by actual panel width Samples in profile, style, color, and texture indicated. Include panel accessories.
- D. Code Compliance: Documents showing product compliance with the national and local building code shall be submitted prior to the bid. These documents shall include, but not be limited to, appropriate Evaluation Reports and/or test reports supporting the use of the product.

1.04 QUALITY ASSURANCE

- A. Installer qualifications: Firm with a minimum of 5 years' experience in installation of exterior metal panels of scope and complexity similar to those of the Project.

- B. Composite Panel Manufacturer shall have a minimum of 20 years' experience in the manufacturing of this product.
- C. Composite Panel Manufacturer shall be solely responsible for panel manufacture and application of the finish.
- D. Fabricator/installer shall be acceptable to the composite panel manufacturer.
- E. Field measurements should be taken prior to the completion of shop fabrication whenever possible. However, coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Field fabrication may be allowed to ensure proper fit. However, field fabrication shall be kept to an absolute minimum with the majority of the fabrication being done under controlled shop conditions.
- F. Shop drawings shall show the preferred joint details providing a structurally sound wall panel system that allows no uncontrolled water penetration on the inside face of the panel system as determined by ASTM E 331. Systems not utilizing a construction sealant at the panel joints (i.e. Rout and Return Dry and Rear Ventilated System) shall provide a means of concealed drainage with baffles and weeps for water which may accumulate in members of the system.
- G. Maximum deviation from vertical and horizontal alignment of erected panels: 1/4-inch in 20-foot non-accumulative.
- H. Panel fabricator/installer shall assume undivided responsibility for all components of the exterior panel system including, but not limited to attachment to sub-construction, panel to panel joinery, panel to dissimilar material joinery, and joint seal associated with the panel system.
- I. Mockup: Erect at the Project site a (visual) composite mockup of the exterior wall, including all the components of the building envelope, as indicated or directed, for review and approval.
 - 1. If the mockup is free-standing, provide a firm foundation for the mockup and make mockup complete with all accessories, and other features required for the final assembly on the building. Glaze mockup.
 - 2. Make modifications necessary to achieve a mockup satisfactory to the Owner and Architect or remove and construct additional mockup(s).
 - 3. Approved mockup shall serve as the standard for the same work on the building.
 - 4. Protect mockup until its removal, if not incorporated in the Work, otherwise remove mockup only after completion and acceptance of final work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Cardboard covers, strippable film or other form of protection standard with the fabricator.
- B. Delivery:
 - 1. Deliver panels and other components so they will not be damaged or deformed.
 - 2. Exercise care in unloading, storing, and erecting panels to prevent bending, warping, twisting, and surface damage.
- C. Storage:
 - 1. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering.

2. Store metal wall and roof panels so that they will not accumulate water.
3. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

1.06 WARRANTY

- A. Furnish panel manufacturer's written warranty covering failure of the factory-applied exterior finish on metal panels within the warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
- B. Warranty period for factory-applied finish is 20 years after Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide MCM panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330:
 1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. of wall area when tested in accordance with ASTM E283 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- C. Water Penetration under Static Pressure: No water penetration to room side of assembly when tested for 15 minutes in accordance with ASTM E331 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Thermal Movements: Locate expansion and contraction points to allow for free and noiseless thermal movements from surface temperature changes.
 1. Temperature Change (Range): minus 20 deg F to 180 deg F, material surfaces.
- E. Design wind pressure: Wind loads prescribed by Code or ANSI A50.1, whichever is more restrictive, but in no case less than 20 psf.
- F. Thermal movements:
 1. Provide assemblies, including anchorage, that accommodate thermal movements of systems and supporting elements resulting from the following maximum change (range) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects.
 2. Temperature change (range): 120-degree F. ambient, 180-degree F. material surfaces.
 3. System performance requirements: Provide certified test results by a recognized testing laboratory or agency (by college) in compliance with specified test methods for each system.

- a. Composite panels shall be capable of withstanding building movements and weather exposures based on the following test standards required by the Architect and/or the local building code.
- b. Panels shall be designed to withstand the design wind load, but in no case less than 20 psf and 30 psf on parapet and corner panels. Wind load testing shall be conducted in accordance with ASTM E 330 with the following results:
 - 1) Normal to the plane of the wall between supports, deflection of the secured perimeter-framing members shall not exceed $L/175$ or 3/4-inch, whichever is less.
 - 2) Normal to the plane of the wall, the maximum panel deflection shall not exceed $L/60$ of the full span.
 - 3) Maximum anchor deflection shall not exceed 1/16-inch.
 - 4) At 1-1/2 times design pressure, permanent deflections of framing members shall not exceed $L/100$ of span length and components shall not experience failure or gross permanent distortion. At connection points of framing members to anchors, permanent set shall not exceed 1/16-inch.
- c. Air infiltration: When tested in accordance with ASTM E 283, air infiltration at 1.57 psf must not exceed 0.06 cfm/ft² of wall area.
- d. Water infiltration - Water infiltration is defined as uncontrolled water leakage through the exterior face of the assembly. Systems not using a construction sealant at the panel joints (i.e. Rout and Return Dry and Rear Ventilated Systems) shall be designed to drain water leakage occurring at the joints. No water infiltration shall occur in system under a differential static pressure of 6.24 psf after 15 minutes of exposure in accordance with ASTM E 331.
- e. Pressure equalized rain screen systems: Comply with AAMA 508 "Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems."
- f. Provide assemblies that always operates quietly and without:
 - 1) Vibration harmonics.
 - 2) Wind whistles.
 - 3) Noises caused by thermal movement (including "popping" and "ticking").
 - 4) Thermal movement transmitted to other building elements.
 - 5) Loosening, weakening or fracturing of attachments or components or system.

2.02 METAL COMPOSITE MATERIAL (MCM) WALL PANELS

- A. MCM Wall Panel Systems: Provide factory-formed and -assembled, MCM wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components panel stiffeners, and accessories required for weathertight system.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide ALUCOBOND®; 3A Composites USA Inc.; ALUCOBOND® PLUS or comparable product by one of the following:
 - a. Arconic Architectural Products (USA).
 - b. Alpolc Materials; Mitsubishi Chemical Composites.
 - c. Or equal.

- B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- (0.50-mm-) thick, anodized aluminum sheet facings.
 - 1. Panel Thickness: 0.157 inch (4 mm).
 - 2. Core: Standard.
 - 3. Peel Strength: 22.5 in-lb/inch when tested for bond integrity in accordance with ASTM D1781.
 - 4. Fire Performance: Flame spread less than 25 and smoke developed less than 450, in accordance with ASTM E84.
- C. Attachment Assembly Components: Formed from extruded aluminum.

2.03 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide Fabricator's standard sections as required for support and alignment of MCM panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of MCM panels unless otherwise indicated.
- C. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent MCM panels.
 - 1. By the panel manufacturer.
- D. Aluminum Trim: Formed with 0.040-inch (1.00-mm-) thick, coil-coated aluminum sheet facings.
- E. Color: Clear anodized aluminum.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of MCM panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- G. Panel Sealants: ASTM C920; silicone sealant; of type, grade, class, and use classifications required to seal joints in MCM panels and remain weathertight; and as recommended in writing by MCM panel manufacturer.

2.04 FABRICATION

- A. General: Fabricate and finish MCM panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations or recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.05 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
1. PVDF Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. FEVE Fluoropolymer: AAMA 2605. One-coat [clear] [tinted] fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
 4. Exposed Anodized Finish:
 - a. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 - b. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM panel supports, and other conditions affecting performance of the Work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by MCM wall panel manufacturer.
 - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by MCM wall panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and assemblies penetrating MCM panels to verify actual locations of penetrations relative to seam locations of MCM panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and MCM panel manufacturer's written recommendations.

3.03 INSTALLATION

- A. General: Install MCM panels in accordance with Drawings and fabricator's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor MCM panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving MCM panels.
 - 2. Flash and seal MCM panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by MCM panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as MCM panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
 - 1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by MCM panel manufacturer.

- D. Attachment Assembly, General: Install attachment assembly required to support MCM wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
 - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
- E. Panel Installation: Attach MCM wall panels to supports at locations, spacings, and with fasteners recommended by Fabricator to achieve performance requirements specified.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete MCM panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by MCM panel Fabricator; or, if not indicated, provide types recommended in writing by MCM system Fabricator.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, or SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.04 ERECTION TOLERANCES

- A. Site Verifications of Conditions:
 - 1. Verify conditions of substrate previously installed under other Sections are acceptable for the MCM system installation. Provide documentation indicating detrimental conditions to the MCM system performance.
 - 2. Once conditions are verified, MCM system installation tolerances are as follows:
 - a. Shim and align MCM wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration in accordance with AAMA 501.2.
- C. Fabricator's Field Service: Engage a factory-authorized service representative to test and inspect completed MCM wall panel installation, including accessories.

- D. MCM wall panels will be considered defective if they do not pass test and inspections.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.06 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as MCM panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of MCM panel installation, clean finished surfaces as recommended by MCM panel manufacturer. Maintain in a clean condition during construction.
- B. After MCM panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 46 46
FIBER-CEMENT SIDING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fiber-cement siding.
2. Fiber-cement soffit.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
2. Section 06 20 13 "Exterior Finish Carpentry" for exterior **[cellular PVC] [and] [foam-plastic]** trim.
3. Section 07 25 00 "Weather Barriers" for weather-resistive barriers.

1.02 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Fiber-cement siding.
2. Fiber-cement soffit.

- B. Product Data Submittals: For each type of fiber-cement **[siding] [and] [soffit]**. [Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.]

- C. Shop Drawings: Submit shop drawings for all trim and flashing conditions.

- D. Samples for Initial Selection: For fiber-cement **[siding] [and] [soffit]** including related accessories.

- E. Samples for Verification: **[For each type, color, texture, and pattern required.]**

1. 12-inch-long-by-actual-width Sample of siding.
2. 24-inch-wide-by-36-inch-high Sample panel of siding assembled on plywood backing.
3. 12-inch-long-by-actual-width Sample of soffit.
4. 12-inch-long-by-actual-width Samples of trim and accessories.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement **[siding] [and] [soffit]**.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.
- D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of fiber-cement **[siding] [and] [soffit]**, including related accessories, to include in maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish full lengths of fiber-cement **[siding] [and] [soffit]** including related accessories, in a quantity equal to 2 percent of amount installed.

1.08 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Build mockups for fiber-cement **[siding] [and] [soffit]** including accessories.
 - a. Size: **[48 inches long by 60 inches high]** <Insert dimensions>.
 - b. Include outside corner on one end of mockup **[and inside corner on other end]**.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracking and deforming.
 - b. Deterioration of materials beyond normal weathering.

- c. Defects shall include, but not be limited to:
 - 1) Cracking.
 - 2) Rotting.
 - 3) Delaminating.
 - 4) Damage due to moisture or termites.
- 2. Warranty Period: **[10] [25] [50]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain products, including related accessories, from single source from single manufacturer.

2.02 FIBER-CEMENT SIDING

- B. Fiber-Cement Siding: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested in accordance with ASTM E136; with a flame-spread index of 25 or less when tested in accordance with ASTM E84.
- C. Labeling: Provide fiber-cement siding that is tested and labeled in accordance with ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- D. Nominal Thickness: Not less than 5/16 inch.
- E. Horizontal Pattern: Boards **[5-1/4 inches] [6-1/4 to 6-1/2 inches] [7-1/4 to 7-1/2 inches] [8-1/4 to 8-1/2 inches] [9-1/4 to 9-1/2 inches]** <Insert dimensions> wide in **[plain] [beaded-edge]** <Insert requirement> style.
 - 1. Texture: **[Smooth] [Rough sawn] [Wood grain]** <Insert requirement>.
- F. Vertical Pattern: 48-inch-wide sheets with wood-grain texture and grooves **[8 inches] [12 inches]** <Insert dimension> o.c.
- G. Shingle Pattern: 48-inch-wide, **[straight-edge notched] [staggered-edge notched]** <Insert requirement> sheets with wood-grain texture.
- H. Panel Texture: 48-inch-wide sheets with **[smooth] [stucco] [wood-grain]** <Insert requirement> texture.
- I. Factory Priming: Manufacturer's standard acrylic primer.

2.03 FIBER-CEMENT SOFFIT

- J. Fiber-Cement Soffit: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested in accordance with ASTM E136; with a flame-spread index of 25 or less when tested in accordance with ASTM E84.
- K. Nominal Thickness: Not less than 5/16 inch.

- L. Pattern: **[12-inch-]** **[16-inch-]** **[24-inch-]** <Insert dimension> wide sheets with **[smooth]** **[wood-grain]** <Insert requirement> texture.
- M. Ventilation: Provide **[perforated]** **[unperforated]** soffit **[unless otherwise indicated]**.
- N. Factory Priming: Manufacturer's standard acrylic primer.

2.04 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.
- B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:
 - 1. Corner posts.
 - 2. Door and window casings.
 - 3. Fasciae.
 - 4. Moldings and trim.
 - 5. **<Insert accessories>**.
- C. Flashing: Provide **[aluminum]** **[stainless steel]** **<Insert metal>** flashing complying with Section 07 62 00 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
 - 1. Finish for Aluminum Flashing: **[Siliconized polyester coating]** **[High-performance organic finish]** **[Factory-prime coating]** **<Insert finish>**.
- D. Fasteners:
 - 1. For fastening to wood, use **[siding nails]** **[ribbed bugle-head screws]** of sufficient length to penetrate a minimum of 1 inch into substrate.
 - 2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch, or three screw-threads, into substrate.
 - 3. For fastening fiber cement, use **[hot-dip galvanized]** **[stainless steel]** fasteners.
- E. Insect Screening for Soffit Vents: **[Aluminum, 18-by-16 mesh]** **[PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 mesh]** **[Stainless steel, 18-by-18 mesh]** **<Insert requirement>**.
- F. Continuous Soffit Vents: Aluminum, hat-channel shape, with **[stamped louvers]** **[perforations]**; 2 inches wide and not less than 96 inches long.
 - 1. Net-Free Area: **[4 sq. in./linear ft.]** **[6 sq. in./linear ft.]** **[8 sq. in./linear ft.]** **<Insert dimension>**.
 - 2. Finish: **[Mill finish]** **[White paint]** **[Brown paint]** **<Insert requirement>**.
- G. Round Soffit Vents: Stamped aluminum louvered vents, **[2 inches]** **[2-1/2 inches]** **[3 inches]** **[4 inches]** **<Insert dimension>** in diameter, made to be inserted in round holes cut into soffit.
 - 1. Finish: **[Mill finish]** **[White paint]** **[Brown paint]** **<Insert requirement>**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement **[siding] [and] [soffit]** and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.03 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 - 1. Do not install damaged components.
 - 2. Install fasteners no more than **[24 inches] <Insert dimension>** o.c.
- B. Install joint sealants as specified in Section 07 92 00 "Joint Sealants" and to produce a weathertight installation.

3.04 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 52 16

STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing system.
2. Base sheet.
3. Cap sheet.
4. Base flashing sheet.
5. Asphalt materials.
6. Accessory roofing system materials.
7. Substrate board.
8. Vapor retarder.
9. Roof insulation.
10. Insulation accessories.
11. Cover board.
12. Walkways.

B. Section includes the installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 05 31 00 "Steel Decking."

C. Related Requirements:

1. Section 05 31 00 "Steel Decking" for roof deck panels **[and sound-absorbing insulation strips]**.
2. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 06 16 00 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 07 71 00 "Roof Specialties" for **[premanufactured metal copings] [roof edge fasciae] [gravel stops] [reglets] [roof edge flashings] [counterflashings]**.
6. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Section 22 14 23 "Storm Drainage Piping Specialties" for roof drains.

1.02 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.03 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at **[Project site] <Insert location>**.

1. Meet with Owner, [**Construction Manager,**] Architect, Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at **[Project site] <Insert location>**.

1. Meet with Owner, [**Construction Manager,**] Architect, Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.04 ACTION SUBMITTALS

- A. Product Data: Submit Data Sheets for each type of product.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:
 - 1. Layout and thickness of insulation.
 - 2. Base flashings and membrane terminations.
 - 3. Flashing details at penetrations.
 - 4. Tapered insulation, including slopes.
 - 5. Roof plan showing orientation of roof deck and orientation of roofing membrane, and fastener spacings and pattern for corner, perimeter, and field-of-roof locations.
 - 6. Crickets, saddles, and tapered edge strips, including slopes.
 - 7. Tie-in with adjoining wall system air barrier.
- C. Samples for Verification: For the following products:
 - 1. Cap Sheet: Samples of [manufacturer's standard colors for selection by Architect] [specified color].
 - a. Size: 12-inches square.
 - 2. Base Flashing Sheet: Samples of [manufacturer's standard colors for selection by Architect] [specified color].
 - a. Size: 12-inches square.
 - 3. Walkways: Samples of [manufacturer's standard colors for selection by Architect] [specified color].
 - a. Size: 12-inches square.
- D. Wind-Uplift Resistance Submittal: For roofing system indicating compliance with wind uplift performance requirements.

1.05 INFORMATIONAL SUBMITTALS

- A. Provide an Assembly Letter describing the complete system to be installed.
- B. Qualification Data: For roofing system **[Installer] [manufacturer] [and] [testing agency]**.
- C. Manufacturer Certificates:
 - 1. Performance Requirement Certificate: Signed by roofing membrane manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 2. Submit evidence of complying with performance requirements.
 - 3. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- D. Product Test Reports: For roofing membrane and insulation, tests performed by a qualified testing agency, indicating compliance with specified requirements.

- E. Evaluation Reports: For components of membrane roofing system, for tests performed by a qualified testing agency.
 - F. Field Test Reports:
 - 1. Concrete internal relative humidity test reports.
 - 2. Fastener pullout test results and manufacturer's revised requirements for fastener patterns.
 - G. Field quality-control reports.
 - H. Sample warranties.
- 1.06 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing system to include in maintenance manuals.
 - B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.
- 1.07 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer that is **[UL listed] [listed in FM Approvals' RoofNav] [listed in SPRI's "Directory of Roof Assemblies"]** for roofing system identical to that used for this Project.
 - B. Installer Qualifications: A qualified firm that is approved, authorized, certified, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
 - B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
 - 1. Protect stored liquid material from direct sunlight.
 - 2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
 - C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.
 - 1. Store in a dry location.
 - 2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
 - D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
- 1.09 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty to include all components of roofing system, such as **[substrate board,] [vapor retarder,]** roof insulation, fasteners, adhesives, **[cover board,] roofing membranes,** base flashing sheet, **[walkway products,] and** other components of roofing system.
 - 2. Warranty Period 30 years from date of Substantial Completion.
- B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as **[substrate board,] [vapor retarder,]** roof insulation, fasteners, adhesives, **[cover board,] roofing membranes,** base flashing sheet, **[walkway products,] and** other components of roofing system.
 - 1. Warranty Period: **[Two] [Five] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain components for roofing system from **[roofing membrane manufacturer] [or] [manufacturer approved by roofing membrane manufacturer].**

2.02 MANUFACTURER

- A. Manufacturers are subject to compliance with requirements; see LACCD Campus Matrix for preferred roofing membrane manufacturer.

2.03 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.
 - 1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" section in FM Approvals 4470.
- B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

- C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:
1. Zone 1 (Roof Area Field): <Insert lbf/sq. ft. >.
 2. Zone 2 (Roof Area Perimeter): <Insert lbf/sq. ft. >.
 - a. Location: From roof edge to <Insert dimension> inside roof edge.
 3. Zone 3 (Roof Area Corners): <Insert lbf/sq. ft. >.
 - a. Location: <Insert dimension> in each direction from each building corner.
- D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
1. Fire/Windstorm Classification: [Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>.
 2. Hail-Resistance Rating: FM 1-34 [MH] [SH] [VSH].
- E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.
1. Wind-Uplift Load Capacity: [60 psf] [75 psf] [90 psf] [105 psf] [120 psf] <Insert capacity>.
- F. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.
- G. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [0.70] <Insert value> and an emissivity of not less than [0.75] <Insert value> when tested in accordance with CRRC S100.
- H. Exterior Fire-Test Exposure: [Class A] [Class B] [Class C]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.
1. Identify products with appropriate markings of applicable testing agency.
- I. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.
1. Identify products with appropriate markings of applicable testing agency.
- 2.04 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM
- A. Roofing System Components: See the following articles for individual roof materials required for [two-] [three-] ply roofing system; [cold-applied adhesive] [self-adhered] [mechanically fastened] installation method.
- 2.05 BASE SHEET
- A. SBS-Modified Bitumen Polyester-Mat Base Sheet: ASTM D6163/D6163M, [Type I] [Type II], Grade S, reinforced with polyester fabric, smooth surfaced, suitable for installation method specified.

- B. SBS-Modified Bitumen Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, **[Type I] [Type II] [Type III]**, Grade S, reinforced with glass fibers, smooth surfaced, suitable for installation method specified.
- C. SBS-Modified Bitumen Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6162/D6162M, **[Type I] [Type II] [Type III]**, Grade S, reinforced with a combination of polyester fabric and glass fibers, smooth surfaced, suitable for installation method specified.
- D. Thickness in accordance with ASTM D5147.

2.06 CAP SHEET

- A. SBS-Modified Bitumen, Granule-Surfaced, Polyester-Mat Cap Sheet: ASTM D6164/D6164M, **[Type I] [Type II]**, Grade G, reinforced with polyester fabric, suitable for installation method specified.
 - 1. Granule Color: **[White] [Highly reflective white] [Gray] [Tan]** <Insert color>.
- B. SBS-Modified Bitumen, Granule-Surfaced, Glass-Fiber-Mat Cap Sheet: ASTM D6163/D6163M, **[Type I] [Type II] [Type III]**, Grade G, SBS-modified asphalt sheet, reinforced with glass fibers, suitable for installation method specified.
 - 1. Granule Color: **[White] [Highly reflective white] [Gray] [Tan]** <Insert color>.
- C. SBS-Modified Bitumen, Granule-Surfaced, Polyester and Glass-Fiber-Mat Cap Sheet: ASTM D6162/D6162M, **[Type I] [Type III]**, Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified.
 - 1. Granule Color: **[White] [Highly reflective white] [Gray] [Tan]** <Insert color>.

2.07 BASE FLASHING SHEET

- A. SBS-Modified Bitumen, Smooth-Surfaced Backer Sheet: Matching base sheet, suitable for installation method specified.
- B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, **[Type I] [Type II]**, asphalt-impregnated and coated glass-fiber sheet, dusted with fine mineral surfacing on both sides, suitable for installation method specified.
- C. SBS-Modified Bitumen, Granule-Surfaced Base Flashing Sheet: Matching cap sheet, suitable for installation method specified.
- D. SBS-Modified Bitumen, Metal-Surfaced Base Flashing Sheet: ASTM D6298/D6298M, metal-foil-surfaced sheet, reinforced with glass fibers, suitable for installation method specified, and as follows:
 - 1. Metal Surfacing: **[Aluminum] [Copper] [Stainless steel] [Aluminum, fluoropolymer-coated finish]**, of color and gloss selected by Architect from manufacturer's full range].
- E. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim, suitable for installation method specified.

2.08 ASPHALT MATERIALS

- A. Asphalt Primer: ASTM D41/D41M.

- B. Roofing Asphalt: ASTM D312/D312M, **[Type III] [Type IV] [Type III or IV as recommended by roofing system manufacturer]**, suitable for installation method specified.
- C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.09 ACCESSORY ROOFING SYSTEM MATERIALS

- A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing components, and suitable for installation method specified.
 - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.
- C. Roof Vents: As recommended in writing by roofing membrane manufacturer.
 - 1. Size: Not less than 4-inch diameter.
- D. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft..
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roofing membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with **[roofing membrane sheets] [and] [base flashing sheets]**; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.
- G. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with **[roofing membrane sheets] [and] [base flashing sheets]**; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.
- H. Liquid Flashings: PMMA or PUMA liquid flashings.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing membrane manufacturer.
- J. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
- K. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.
- L. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

- M. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing No. 8 sieve and 98 percent of mass retained on No. 40 sieve; color matching cap sheet.
- N. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.
- O. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.10 SUBSTRATE BOARD

- A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Thickness: **[1/4 inch] [1/2 inch] [Type X, 5/8 inch]**.
 - 2. Surface Finish: **[Factory primed] [Unprimed]**.
- B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.
 - 1. Thickness: **[1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]**.
- C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, 1/2 inch thick, having a minimum compressive strength of 80 psi.
- D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.11 VAPOR RETARDER

- A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
- B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
- C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.
 - 1. Permeance Rating: Not more than 0.062 perm when tested in accordance with ASTM E96/E96M.
 - 2. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
 - 3. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
 - 4. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.12 ROOF INSULATION

- A. General: Preformed roof insulation boards, manufactured **[or approved]** by roofing membrane manufacturer, approved for use in **[FM Approvals' RoofNav listed roof assemblies] [SPRI's "Directory of Roof Assemblies" listed roof assemblies]**.
- B. Extruded Polystyrene Board Insulation: ASTM C578, **[Type IV, 1.6 lb/cu. ft. minimum density, 25 psi minimum compressive strength] [Type V, 3.00 lb/cu. ft. minimum density, 100 psi minimum compressive strength]**, square edged.
1. Thermal Resistance: R-value of 5.0 per 1 inch.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness:
 - a. Base Layer: **[1-1/2 inches]** <Insert thickness>.
 - b. Upper Layer: **<Insert thickness>**.
- C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, 1.15 lb/cu. ft. minimum density, 13 psi minimum compressive strength, square edge.
1. Thermal Resistance: R-value of 3.8 per 1 inch.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness:
 - a. Base Layer: **[1-1/2 inches]** <Insert thickness>.
 - b. Upper Layer: **<Insert thickness>**.
- D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, **[Type II, 1.35 lb/cu. ft.] [Type VIII, 1.15 lb/cu. ft.] [Type IX, 1.8 lb/cu. ft.]** minimum density, with factory-applied facings, as follows:
1. Facer: **[ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch thick] [DOC PS 2, Exposure 1, oriented strand board, 7/16 inch thick]** <Insert material>.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness: <Insert thickness>.
- E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, **[Grade 2] [Grade 3]**, felt or glass-fiber-mat facer on both major surfaces.
1. Compressive Strength: **[20 psi] [25 psi]**.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 - a. Thickness:
 - b. Base Layer: **[1-1/2 inches]** <Insert thickness>.
 - c. Upper Layer: **<Insert thickness>**.
- F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber-mat facer on the other surface.
1. Facer: **[Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch thick] [Type V oriented strand board facer, 7/16 inch thick] [Type VII glass-mat-faced gypsum board facer, 1/4 inch thick]** <Insert material>.

2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness: <Insert thickness>.
- G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
1. Thermal Resistance: R-value of 2.78 per 1 inch.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness:
 - a. Base Layer: **[1-1/2 inches]** <Insert thickness>.
 - b. Upper Layer: **<Insert thickness>**.
- H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
1. Thermal Resistance: R-value of 2.78 per 1 inch.
 2. Size: **[48 by 48 inches] [48 by 96 inches]**.
 3. Thickness:
 - a. Base Layer: **[1 inch] [2 inches]** <Insert thickness>.
 - b. Upper Layer: **<Insert thickness>**.
- I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
1. Thermal Resistance: R-value of 3.44 per 1 inch.
 2. Size: 24 by 48 inches.
 3. Thickness: <Insert thickness>.
- J. Mineral Wool Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with a 11.2 lb/cu. ft. density and a lower layer with a 7.5 lb/cu. ft. density.
1. Thermal Resistance: R-value of 3.8 per 1 inch.
 2. Size: 48 by 48 inches.
 3. Thickness:
 - a. Base Layer: **[2 inches]** <Insert thickness>.
 - b. Upper Layer: **<Insert thickness>**.
 4. Face Treatment: Bitumen coating.
- K. Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a 12.5 lb/cu. ft. density.
1. Thermal Resistance: R-value of 4.0 per 1 inch.
 2. Size: 48 by 48 inches.
 3. Thickness: 1 inch.
 4. Face Treatment: Bitumen coating.

- L. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: **[Match roof insulation]** <Insert material>.
 - 2. Minimum Thickness: 1/4 inch.
 - 3. Slope:
 - a. Roof Field: **[1/4 inch per foot]** <Insert slope> unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: **[1/2 inch per foot]** <Insert slope> unless otherwise indicated on Drawings.

2.13 INSULATION ACCESSORIES

- A. General: Roof insulation accessories as recommended in writing by roof membrane manufacturer for intended use, compatible with other roofing system components and suitable for installation method specified.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing membrane manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation **[to substrate]** **[and]** to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 - 3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
- D. Insulation Cant Strips: **[ASTM C728, perlite insulation board]** **[ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board]**.
- E. Wood Nailer Strips: Comply with requirements in Section 06 10 00 "Rough Carpentry."
- F. Tapered Edge Strips: **[ASTM C728, perlite insulation board]** **[ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board]**.

2.14 COVER BOARD

- A. General: Cover board as recommended in writing by roof membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.
- B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of 40 psi.
 - 1. Thickness: **[1/2 inch]** **[1 inch]** <Insert thickness>.
 - 2. Surface Finish: **[Primed one side]** **[Primed two sides with non-asphaltic primer]** **[Integral coating, six sides]** **[Unprimed]** <Insert finish>.
- C. Oriented Strand Board: DOC PS 2, Exposure 1, 7/16 inch thick.
- D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Thickness: **[1/4 inch]** **[1/2 inch]** **[5/8 inch]**.

2. Surface Finish: [Fiberglass facer] [Factory primed] [Unprimed].
- E. Fiber-Reinforced Gypsum Panel Cover Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.
 1. Thickness: [1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]
- F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.
 1. Thickness: [7/16 inch] [1/2 inch] [5/8 inch].
- G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.
 1. Thickness: [1/4 inch] [1/2 inch].
 2. Surface Finish: [Fiberglass facer] [Paper facer].
- H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, 1/2 inch thick, having a minimum compressive strength of 80 psi.
- I. Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 1, 1/2 inch thick.

2.15 WALKWAYS

- A. Walkway Pads: [Reinforced asphaltic composition pads with slip-resisting mineral-granule surface] [Polymer-modified, reconstituted rubber pads with slip-resisting textured surface], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.
 1. Pad Size: Approximately [36 by 60 inches] [30 by 30 inches] <Insert size>.
 2. Color: [Contrasting with cap sheet] [Gray] [Yellow] [White] <Insert color>.
- B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:
 1. Size: [30 by 60 inches] <Insert size>.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Roofing System Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 "Steel Decking."
 4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
 5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.

6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than **[75] <Insert number>** percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.
 - a. Test Frequency: One test probe per each **[1000 sq. ft.] <Insert area>**, or portion thereof, of roof deck, with not less than three test probes.
 - b. Submit test reports within 24 hours of performing tests.
 7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
 8. Verify that joints in concrete roof decks have been grouted flush with top of concrete.
 9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
 10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
 11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch at top surface.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.
 1. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
 1. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Prime surface of concrete roof deck with asphalt primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.
- D. Perform fastener-pullout tests in accordance with roofing system manufacturer's recommendations.
 1. Submit test result within 24 hours of performing tests.
 - a. Include roofing system manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
- E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with acoustical roof deck manufacturer's written installation instructions.

3.03 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, **[FM Approvals' RoofNav listed roof] [SPRI's "Directory of Roof Assemblies" listed roof]** assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition **[and to not void warranty for existing roofing system]**.
- D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified in Section 07 27 26 "Fluid-Applied Membrane Air Barriers."
- E. Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.
1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before installation.
 2. Circulate asphalt during heating.
 3. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of installation.
 4. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
 5. Do not heat asphalt within 25 deg F of flash point.
 6. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
 7. Apply hot asphalt within plus or minus 25 deg F of equiviscous temperature.
- F. SEBS-Modified Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.
- G. Substrate-Joint Penetrations: Prevent hot-applied asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.04 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
 2. Tightly butt substrate boards together.
 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 4. Fasten substrate board to top flanges of steel roof deck in accordance with roofing system manufacturer's written installation instructions and **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified Wind-Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29.
 5. Fasten substrate board to top flanges of steel roof deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written installation instructions.
 6. Loosely lay substrate board over roof deck.

3.05 INSTALLATION OF VAPOR RETARDER

- A. Loosely lay vapor retarder sheet in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.
 - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
 - 2. Continuously seal side and end laps.
- B. Prime substrate, if required by manufacturer. Install sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
 - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
 - 2. Seal laps by rolling.
- C. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSTALLATION OF INSULATION

- A. Coordinate installation of roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.
- C. Install each layer of insulation with [joints staggered not less than **24 inches** in adjacent rows] [end joints staggered not less than **12 inches** in adjacent rows] and offset not less than 12 inches from previous layer.
 - 1. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - 3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches.
 - 4. Trim insulation, so that water flow is unrestricted.
 - 5. Fill gaps exceeding 1/4 inch with insulation.
 - 6. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - 7. Secure insulation in accordance with [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's "Directory of Roof Assemblies" for specified Wind-Uplift Load Capacity].
 - 8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
- D. Nailer Strips: Mechanically fasten 4-inch nominal-width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
 - 1. **[16 ft.] <Insert dimension>** apart for roof slopes greater than 1 inch per 12 inches but less than 3 inches per 12 inches.
 - 2. **[48 inches] <Insert dimension>** apart for roof slopes greater than 3 inches per 12 inches.

- E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 degrees.

3.07 INSTALLATION OF COVER BOARD

- A. Comply with roofing system and insulation manufacturer's written installation instructions.
- B. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 2. At internal roof drains, conform to slope of drain sump.
 3. Trim cover board, so that water flow is unrestricted.
 4. Cut and fit cover board tight to nailers, projections, and penetrations.
 5. Secure cover board to insulation in accordance with [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified Wind-Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29.
 6. Secure cover board to resist specified uplift pressure at corners, perimeter, and field of roof.
- C. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.08 INSTALLATION OF ELD COMPONENTS

- A. Install conductive medium over **[cover board] [insulation] [and on vertical locations to receive roofing membrane]** in accordance with manufacturer's written installation instructions.
- B. Install sensors, **[wire loop,] [conductive fabric,]** connections, and accessory items required for complete system in accordance with manufacturer's written installation instructions.

3.09 INSTALLATION OF ROOFING MEMBRANE, GENERAL

- A. Install roofing system in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel **[and Owner's testing and inspection agency]**.
- C. Where roof slope exceeds **[1/2 inch per 12 inches] [3/4 inch per 12 inches] <Insert slope>**, install roofing membrane sheets parallel with slope.
 1. Backnail roofing sheets to **[nailer strips] [substrate]** in accordance with roofing system manufacturer's written installation instructions.
- D. Coordinate installation of roofing system so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in adhesive, with joints and edges sealed.
2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.10 INSTALLATION OF BASE SHEET

- A. Prime surface of substrate with primer in accordance with roofing membrane manufacturer's written installation instructions and allow primer to dry.
- B. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which base sheet will be installed.
- C. Loosely lay one course of sheathing paper, lapping edges, and ends a minimum of 2 inches and 6 inches, respectively.
- D. Installation of Base Sheet:
 1. Install base sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
 2. Extend base sheet over and terminate above cants.
 3. Install base sheet in a shingle fashion.
 4. Adhere base sheet to substrate in a uniform coating of **[hot-applied asphalt] [cold-applied adhesive]**.
 5. Self-adhere base sheet to substrate.
 6. Mechanically fasten base sheet to substrate using fasteners specifically designed and sized for **[wood] [wood panel]** decks.
 - a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
 7. Install base sheet without wrinkles or rears, and free from air pockets.
 8. Laps: Accurately align base sheet, without stretching, and maintain uniform side and end laps.
 - a. Lap side laps as recommended by roofing membrane manufacturer but not less than 3 inches.
 - b. Lap end laps as recommended by roofing membrane manufacturer but not less than 12 inches. Stagger end laps not less than 18 inches.
 - c. Completely bond and seal laps, leaving no voids.
 - d. Roll laps with a 20 lb roller.
 9. Repair tears and voids in laps and lapped seams not completely sealed.
 10. Apply pressure to body of base sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.
- E. Installation of Vented Base Sheet:

1. [Mechanically fasten, using fasteners specifically designed and sized for applicable substrate] [Spot or strip mop to substrate with hot-applied asphalt] vented base sheet with vented side down.
 - a. Fasten vented base sheet in accordance with [FM Approval's RoofNav for specified Windstorm Resistance Classification] [SPRI's "Directory of Roof Assemblies" for specified Wind-Uplift Load Capacity].
 - b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.11 INSTALLATION OF CAP SHEET

- A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.
- B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
 1. Extend cap sheet over and terminate above cants.
 2. Install cap sheet in a shingle fashion.
 3. Adhere cap sheet to bottom layer in a uniform coating of **[hot-applied asphalt]** **[cold-applied adhesive]**.
 4. Self-adhere cap sheet to bottom layer.
 5. Mechanically fasten cap sheet to bottom layer using fasteners specifically designed and sized for **[wood]** **[wood panel]** decks.
 - a. Fasten cap sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
 6. Install cap sheet without wrinkles or tears, and free from air pockets.
 7. Install cap sheet so side and end laps shed water.
- C. Laps: Accurately align roof sheets, without stretching, and maintain uniform side and end laps.
 1. Lap side laps as recommended by roofing membrane manufacturer but not less than 3 inches.
 2. Lap end laps as recommended by roofing membrane manufacturer but not less than 12 inches. Stagger end laps not less than 18 inches.
 3. Completely bond and seal laps, leaving no voids.
 4. Roll laps with a 20 lb roller.
 5. Repair tears and voids in laps and lapped seams not completely sealed.
- D. Apply pressure to body of cap sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and result in complete adhesion of cap sheet to substrate.
- E. Apply roofing granules of same color as cap sheet to cover exuded bead at laps while bead is hot, to provide a continuous color appearance.

3.12 INSTALLATION OF BASE FLASHING AND STRIPPING

- A. Install base flashing sheet over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates in accordance with roofing system manufacturer's written installation instructions and as follows:
1. Prime substrates with asphalt primer if required by roofing system manufacturer.
 2. Backer Sheet Installation: [Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants] [Adhere backer sheet to substrate in a uniform layer of] cold-applied adhesive.
 3. Base Flashing Sheet Installation, Hot: Adhere base flashing sheet to substrate in a solid mopping of hot-applied asphalt applied at asphalt temperature recommended by base flashing sheet manufacturer. Apply hot-applied asphalt to back of base flashing sheet if recommended by roofing system manufacturer.
 - a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.
 4. Base Flashing Sheet Installation, Cold: Adhere base flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
- B. Extend base flashing sheet up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.
- C. Mechanically fasten top of base flashing sheet securely at terminations and perimeter of roof.
1. Seal top termination of base flashing sheet.
- D. Install liquid flashing system in accordance with roofing system manufacturer's written installation instructions.
1. Extend liquid flashing not less than 3 inches in all directions from edges of item being flashed.
 2. Embed granules, matching color of cap sheet, into wet compound.
- E. Install cap sheet stripping where metal flanges and edgings are set on roof in accordance with roofing system manufacturer's written installation instructions.
- F. Roof Drains: Set **[30-by-30-inch-]** <Insert dimensions> 4 lb flashing in bed of adhesive on completed roofing membrane.
1. Cover flashing with cap sheet stripping, and extend a minimum of **[4 inches]** **[6 inches]** beyond edge of metal flashing onto field of roofing membrane.
 2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
 3. Install stripping in accordance with roofing system manufacturer's written installation instructions.

3.13 INSTALLATION OF LIQUID FLASHINGS

- A. Preparation of Metal Substrates: Grind to generate a "bright metal" surface and remove loose particles. Extend preparation area a minimum of 1/2-inch (13 mm) beyond the termination of the roofing/flashing system. Notch steel surfaces to provide a rust-stop where detailed.
- B. Base Flashing Application:
1. Using masking tape, mask the perimeter of the area to receive the flashing system. Apply resin primer to substrates requiring additional preparation and allow primer to cure.

2. Pre-cut fleece to ensure a proper fit at transitions and corners prior to membrane application.
3. Apply an even, generous base coat of flashing resin to prepared surfaces using a roller at the rate specified by the resin manufacturer. Work the fleece into the wet, catalyzed resin using a brush or roller to fully embed the fleece in the resin and remove trapped air. Lap fleece layers a minimum of 2 inch (5 cm) and apply an additional coat of catalyzed resin between layers of overlapping fleece. Again using a roller, apply an even top coat of catalyzed resin immediately following embedment of the fleece at the rate specified by the resin manufacturer, ensuring that the fleece is fully saturated. Ensure that the flashing resin is applied to extend beyond the fleece (maximum ¼-inch (6 mm)). Remove the tape before the catalyzed resin cures. Make allowances for waste, including saturation of roller covers and application equipment.
4. Should work be interrupted for more than 12 hours or the surface of the cured resin becomes dirty or contaminated by the elements, wipe the surface to be lapped with new flashing resin using the specified cleaner/solvent. Allow the surface to dry for a minimum 20 minutes and a maximum 60 minutes before continuing work.

3.14 INSTALLATION OF WALKWAYS

- A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size; secure to cap sheet in accordance with roofing system manufacturer's written installation instructions.
 1. Install walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roofing system manufacturer's warranty requirements.
 2. Provide 3-inch clearance between adjoining pads.
- B. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane, using same installation method as that used for cap sheet.
 1. Install walkways strips at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

- f. Locations indicated on Drawings.
 - g. As required by roofing membrane manufacturer's warranty requirements.
2. Provide 3-inch clearance between adjoining strips.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roofing membrane installation, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform the following tests:
- 1. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.
 - a. Perform tests before overlying construction is placed.
 - b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing, or by nuclear hydrogen detection testing.
 - c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - d. Cost of retesting is Contractor's responsibility.
 - e. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture if any.
- C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
- 1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
 - 2. Examine test specimens for voids between plies in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 of NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."
 - 3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.
- D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- 1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- F. Roofing system will be considered defective if it does not pass tests and inspections.
- 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.16 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.17 ROOFING SYSTEM INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:
1. Owner: <Insert name of Owner>.
 2. Owner Address: <Insert address>.
 3. Building Name/Type: <Insert information>.
 4. Building Address: <Insert address>.
 5. Area of Work: <Insert information>.
 6. Warranty Period: **[Two] [Five]** <Insert number> years from date of Substantial Completion..
 7. Date of Substantial Completion: _____.
- B. AND WHEREAS Roofing System Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert mph>;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
 - f. vapor condensation on bottom of roofing; and

- g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
- 2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
- 3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
- 4. During Warranty Period, if Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
- 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
- 6. Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work to examine evidence of such leaks, defects, or deterioration.
- 7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of

_____, _____.

- 1. Authorized Signature: _____.
- 2. Name: _____.
- 3. Title: _____.

END OF SECTION

SECTION 07 54 19

POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.

B. Section includes installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 05 31 00 "Steel Decking."

C. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 06 16 00 "Sheathing" for wood-based, structural-use roof deck panels.
3. Section 07 21 00 "Thermal Insulation" for insulation beneath the roof deck.
4. Section 07 27 19 "Self-Adhered Sheet Membrane Air & Water Barrier".
5. Section 07 27 26 "Fluid Applied Air, Water and Vapor Barrier" *.
6. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
7. Section 07 71 00 "Roof Specialties" for [premanufactured copings] [and] [roof edge flashings].
8. Section 07 71 29 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
9. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
10. Section 22 14 23 "Storm Drainage Piping Specialties" for roof drains.

1.02 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.03 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [Project site] <Insert location>.

1. Meet with Owner, Architect, [Construction Manager,] Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [Project site] <Insert location>.

1. Meet with Owner, Architect, [Construction Manager,] Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Polyvinyl chloride (PVC) roofing system.
 - 2. Accessory roofing materials.
 - 3. Substrate board.
 - 4. Vapor retarder.
 - 5. Roof insulation.
 - 6. Insulation accessories and cover board.
 - 7. Asphalt materials.
 - 8. Electronic leak detection (ELD) materials.
 - 9. Ballast.
 - 10. Walkways.
 - 11. For insulation and roof system component fasteners, include copy of [FM Approvals' RoofNav] [SPRI's Directory of Roof Assemblies] listing.

 - B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
 - 1. Layout and thickness of insulation.
 - 2. Base flashings and membrane terminations.
 - 3. Flashing details at penetrations.
 - 4. Retain one or more subparagraphs below.
 - 5. Tapered insulation thickness and slopes.
 - 6. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
 - 7. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
 - 8. Tie-in with air barrier.

 - C. Samples for Verification: For the following products:
 - 1. Retain one or more subparagraphs below.
 - 2. Roof membrane and flashing, of color required.
 - 3. Aggregate surfacing material in gradation [and color] required.
 - 4. Roof paver [, full sized,] in each color and texture required.
 - 5. Walkway pads or rolls, of color required.

 - D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer and manufacturer.
 - B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Field Test Reports:
1. Concrete internal relative humidity test reports.
 2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- F. Field quality-control reports.
- G. Sample Warranties: For manufacturer's special warranties.
- H. LEED Documentation: Submit documentation showing design compliance.
- 1.06 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing system to include in maintenance manuals.
 - B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.
- 1.07 QUALITY ASSURANCE
- A. Qualifications:
1. Manufacturers: A qualified manufacturer that is [UL listed] [listed in FM Approvals' RoofNav] [listed in SPRI's Directory of Roof Assemblies] for roofing system identical to that used for this Project.
 2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
 - B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.09 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roof membrane, base flashings, [roof insulation,] [fasteners,] [cover boards,] [substrate board,] [roof pavers,] and other components of roofing system.
 - 2. Warranty Period: 30 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, [roof insulation,] [fasteners,] [cover boards,] [substrate boards,] [vapor retarders,] [roof pavers,] and [walkway products,] for the following warranty period:
 - 1. Warranty Period: [Two] <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.
 - 1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
 - 1. Zone 1 (Roof Area Field): <Insert lbf/sq. ft.>.

2. Zone 2 (Roof Area Perimeter): <Insert lbf/sq. ft.>.
 - a. Location: From roof edge to <Insert dimension> inside roof edge.
 3. Zone 3 (Roof Area Corners): <Insert lbf/sq. ft.>.
 - a. Location: <Insert dimension> in each direction from building corner.
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
1. Fire/Windstorm Classification: [Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>.
 2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [MH] [SH] [VSH].
- E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
1. Wind Uplift Load Capacity: [60 psf] [75 psf] [90 psf] [105 psf] [120 psf] <Insert capacity>.
- F. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for [low] [steep]-slope roof products.
- G. Energy Performance: Roofing system to have an initial solar reflectance of not less than [0.70] <Insert value> and an emissivity of not less than [0.75] <Insert value> when tested in accordance with ANSI/CRRC S100.
- H. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [Class A] [Class B] [Class C]; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- I. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.
- 2.02 POLYVINYL CHLORIDE (PVC) ROOFING SYSTEM
- A. PVC Sheet Type III: ASTM D4434/D4434M, fabric reinforced.
1. Thickness: [50 mils] [60 mils] [80 mils] <Insert value>.
 2. Exposed Face Color: [White] [Gray] <Insert color>.
- B. PVC Sheet Type III, Fabric Backed: ASTM D4434/D4434M, fabric reinforced and fabric backed.
1. Membrane Thickness: [50 mils] [60 mils] [80 mils] <Insert value>.
 2. Exposed Face Color: [White] [Gray] <Insert color>.
- C. PVC Sheet Type II: ASTM D4434/D4434M, glass-fiber reinforced, felt backed.
1. Thickness: [60 mils] [72 mils] [80 mils] <Insert value>.
 2. Exposed Face Color: [Copper brown] [Evergreen] [Lead gray] [Patina green] <Insert color>.

- D. PVC Sheet Type II, Fabric Backed: ASTM D4434/D4434M, glass-fiber reinforced, fabric backed.
 - 1. Thickness: [50 mils] [60 mils] [80 mils] <Insert value>.
 - 2. Exposed Face Color: White.
- E. PVC Sheet Type IV: ASTM D4434/D4434M, fabric reinforced.
 - 1. Thickness: [40 mils] <Insert value>.
 - 2. Exposed Face Color: [White] [Tan] [Gray] [Dark gray] <Insert color>.
- F. PVC Nitrate Alloy Sheet: ASTM D4434/D4434M, Type III, polyester-reinforced, thermoplastic acrylonitrile-butadiene polymer (NBP) blend.
 - 1. Thickness: [50 mils, minimum] [60 mils] [80 mils] <Insert value>.
 - 2. Exposed Face Color: [White] [Tan] [Gray] <Insert color>.
- G. PVC Nitrate Alloy Sheet, Fabric Backed: ASTM D4434/D4434M, Type III, polyester-reinforced, thermoplastic acrylonitrile-butadiene polymer (NBP) blend; fabric backed.
 - 1. Membrane Thickness: 50 mils.
 - 2. Exposed Face Color: [White] [Tan] [Gray] <Insert color>.
- H. PVC Ketone Ethylene Ester (KEE) Sheet: ASTM D4434/D4434M, Type III.
 - 1. Membrane Thickness: [50 mils] [60 mils] [80 mils] <Insert value>.
 - 2. Exposed Face Color: [White] [Tan] [Gray] <Insert color>.
- I. PVC Ketone Ethylene Ester (KEE) Sheet, Fabric Backed: ASTM D4434/D4434M, Type III, with fabric backing.
 - 1. Membrane Thickness: [50 mils] [60 mils] [80 mils] <Insert value>.
 - 2. Exposed Face Color: [White] [Tan] [Gray] <Insert color>.
- J. Source Limitations: Obtain components for roofing system from [roof membrane manufacturer] [or] [manufacturers approved by roof membrane manufacturer].

2.03 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Liquid Flashings: PMMA or PUMA liquid flashings.
- C. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Roof Vents: As recommended by roof membrane manufacturer.
 - 1. Size: Not less than 4-inch diameter.
- F. Bonding Adhesive: Manufacturer's standard [, water based].

- G. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
- H. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.
 - 1. Slip Sheet: [ASTM D2178/D2178M, Type IV, glass fiber, asphalt-impregnated felt] [Manufacturer's standard, of thickness required for application].
- I. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt-impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.
- J. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- K. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
- L. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.
 - 1. Fasteners: 1-1/2-inch stainless steel fasteners with neoprene washers.
- M. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- N. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.04 SUBSTRATE BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: 5/8 inch.
- B. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Thickness: [1/4 inch] [1/2 inch] [Type X, 5/8 inch].
 - 2. Surface Finish: [Factory primed] [Unprimed].
- C. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.
 - 1. Thickness: [1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch].
- D. Perlite Board: ASTM C728, sealed coated.
 - 1. Thickness: [3/4 inch] [1 inch].

- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.05 VAPOR RETARDER

- A. Polyethylene Film: ASTM D4397, [6 mils] [10 mils] thick, minimum, with maximum permeance rating of [0.13 perm] [0.76 perm].
 - 1. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.
 - 2. Adhesive: Manufacturer's standard lap adhesive, listed by FM Approvals for vapor retarder application.
- B. Laminated Sheet Vapor Retarder: Two layer, fire-retardant polyethylene laminate, reinforced with cord grid.
 - 1. Permeance Rating: Not more than 0.062 perm when tested in accordance with ASTM E96/E96M.
 - 2. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
 - 3. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
 - 4. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.
- D. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.
- E. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.06 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured [or approved] by PVC roof membrane manufacturer [, approved for use in FM Approvals' RoofNav listed roof assemblies] [, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies].
- B. Extruded-Polystyrene Board Insulation: ASTM C578, [Type IV, 1.45-lb/cu. ft.] [minimum density, 25 psi minimum compressive strength] [Type V, 3.00-lb/cu. ft. minimum density, 100 psi minimum compressive strength], square edged.
 - 1. Thermal Resistance: R-value of 5.0 per 1 inch.
 - 2. Size: [48 by 48 inches] [48 by 96 inches].
 - 3. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.

- C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, 1.15-lb/cu. ft. minimum density, 13-psi minimum compressive strength, square edge.
1. Thermal Resistance: R-value of 3.8 per 1 inch.
 2. Size: [48 by 48 inches] [48 by 96 inches].
 3. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [Type II, 1.35-lb/cu. ft.] [Type VIII, 1.15-lb/cu. ft.] [Type IX, 1.8-lb/cu. ft.] minimum density, with factory-applied facings, as follows:
1. Facer: [ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch thick] [DOC PS 2, Exposure 1, oriented strand board, 7/16 inch thick] <Insert material>.
 2. Size: [48 by 48 inches] [48 by 96 inches].
 3. Thickness: <Insert thickness>.
- E. Polyisocyanurate Board Insulation: ASTM C1289, [Type II, Class 1, Grade 2] [Type II, Class 2, Grade 2], felt or glass-fiber mat facer on both major surfaces.
1. Compressive Strength: [20 psi] [25 psi].
 2. Size: [48 by 48 inches] [48 by 96 inches].
 3. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
1. Facer: [Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch thick] [Type V, oriented strand board facer, 7/16 inch thick] [Type VII, glass-mat-faced gypsum board facer, 1/4 inch thick] <Insert material>.
 2. Size: [48 by 48 inches] [48 by 96 inches].
 3. Thickness: <Insert thickness>.
- G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
1. Thermal Resistance: R-value of 2.78 per 1 inch.
 2. Size: [48 by 48 inches] [48 by 96 inches].
 3. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.

- H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
1. Thermal Resistance: R-value of 2.78 per 1 inch.
 2. Size: **[48 by 48 inches]** **[48 by 96 inches]**.
 3. Thickness:
 - a. Base Layer: **[1 inch]** **[2 inches]** <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- I. Cellular Glass Board Insulation: ASTM C552, Type IV, rigid, cellular glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
1. Thermal Resistance: R-value of 3.44 per 1 inch.
 2. Size: 24 by 48 inches.
 3. Thickness: <Insert thickness>.
- J. Mineral Wool Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of 11.2-lb/cu. ft. density, and a lower layer of 7.5-lb/cu. ft. density.
1. Thermal Resistance: R-value of 3.8 per 1 inch.
 2. Size: 48 by 48 inches.
 3. Thickness:
 - a. Base Layer: **[2 inches]** <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
 4. Face Treatment: Bitumen coating.
- K. Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having 12.5-lb/cu. ft. density.
1. Thermal Resistance: R-value of 4.0 per 1 inch.
 2. Size: 48 by 48 inches.
 3. Thickness: 1 inch.
 4. Face Treatment: Bitumen coating.
- L. Tapered Insulation: Provide factory-tapered insulation boards.
1. Material: **[Match roof insulation]** <Insert material>.
 2. Minimum Thickness: 1/4 inch.
 3. Slope:
 - a. Roof Field: **[1/4 inch per foot]** <Insert slope> unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: **[1/2 inch per foot]** <Insert slope> unless otherwise indicated on Drawings.

2.07 INSULATION ACCESSORIES AND COVER BOARD

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation [and cover boards] to substrate, and acceptable to roofing system manufacturer.
- C. Induction-Welding Plates: Minimum 3-inch diameter with recessed center, 0.034-inch thick, aluminum-zinc-alloy-coated steel plates, factory-coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners [and thermal isolation spacers below plates].
- D. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, one-component, or multicomponent urethane adhesive.
 - 3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
- E. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of 40 psi.
 - 1. Thickness: [1/2 inch] [1 inch] <Insert thickness>.
 - 2. Surface finish: [Primed one side] [Primed two sides with non-asphaltic primer] [Integral coating, six sides] [Unprimed] <Insert finish>.
- F. Oriented Strand Board: DOC PS 2, Exposure 1, 7/16 inch thick.
- G. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Thickness: [1/4 inch] [1/2 inch] [5/8 inch].
 - 2. Surface Finish: [Fiberglass facer] [Factory primed] [Unprimed].
- H. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.
 - 1. Thickness: [1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch].
- I. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.
 - 1. Thickness: [7/16 inch] [1/2 inch] [5/8 inch].
- J. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.
 - 1. Thickness: [1/4 inch] [1/2 inch].
 - 2. Surface finish: [Fiberglass facer] [Paper facer].
- K. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, 1/2 inch thick, having a minimum compressive strength of 80 psi.
- L. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.08 ASPHALT MATERIALS

- A. Roofing Asphalt: [ASTM D312/D312M, Type III or Type IV] [ASTM D6152/D6152M, SEBS modified].
- B. Asphalt Primer: ASTM D41/D41M.

2.09 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

- A. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.
 - 1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer [, UL listed and FM Global approved].
 - 2. Grounding Screen: [Welded, stainless steel mesh] [Aluminum screen], for use with vector mapping system [, FM Global approved].
 - 3. Electrically Conductive Fabric: Non-abrasive felt.
- B. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.
 - 1. Sensors measuring moisture content [, temperature, and vapor drive], placed [below roof insulation] [over vapor barrier] and connected to a monitoring program, with a notification indicating location of breach.
 - 2. Sensors measuring moisture content [, temperature, and vapor drive], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

- A. Aggregate Ballast: [Smooth, washed, riverbed gravel or other acceptable smooth-faced stone] [Crushed gravel or crushed stone] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:
 - 1. Size: [ASTM D448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches] [ASTM D448, Size 3, ranging in size from 1 to 2 inches] [Size 4, ranging in size from 3/4 to 1-1/2 inches] <Insert size>.
- B. Lightweight Roof Pavers: Interlocking, lightweight concrete units, grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
 - 1. Size: <Insert actual size(s) of pavers>.
 - 2. Weight: <Insert weight or weight range>.
 - 3. Compressive Strength: [2500 psi] [5000 psi] <Insert value>, minimum.
 - 4. Colors and Textures: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].
- C. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, [square edged] [with top edges beveled 3/16 inch], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:
 - 1. Size: [24 by 24 inches] <Insert dimensions>. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.

2. Weight: [18 lb/sq. ft.] [22 lb/sq. ft.] <Insert value>.
3. Compressive Strength: [7500 psi] [6500 psi] <Insert value>, minimum.
4. Colors and Textures: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

2.11 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [pads] [or] [rolls], approximately 3/16 inch thick and acceptable to roofing system manufacturer.
 1. Size: Approximately 36 by 60 inches.
 2. Color: Contrasting with roof membrane.
- B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [square edged] [with top edges beveled 3/16 inch], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:
 1. Size: [24 by 24 inches] <Insert dimensions>. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.
 2. Weight: [18 lb/sq. ft.] [22 lb/sq. ft.] <Insert value>.
 3. Compressive Strength: [7500 psi] [6500 psi] <Insert value>, minimum.
 4. Colors and Textures: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 "Steel Decking."
 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [75] <Insert number> percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
 - a. Test Frequency: One test probe per each [1000 sq. ft.] <Insert area>, or portion thereof, of roof deck, with no fewer than three test probes.
 - b. Submit test reports within 24 hours of performing tests.

6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
 7. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
 8. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
 9. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
 10. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch at top surface.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 1. Submit test result within 24 hours of performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
- D. Install sound-absorbing insulation strips according to acoustical roof deck manufacturer's written instructions.

3.03 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, [FM Approvals' RoofNav] [SPRI's Directory of Roof Assemblies] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition [and to not void warranty for existing roofing system].
- D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 07 27 19 "Self-Adhered Sheet Membrane Air & Water Barrier" and Section 07 27 26 "Fluid-Applied Membrane Air Barriers."

3.04 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck according to recommendations in [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
6. Loosely lay substrate board over roof deck.

3.05 INSTALLATION OF VAPOR RETARDER

- A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.
 1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
 2. Continuously seal side and end laps with [tape] [adhesive].
- B. Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.
 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
 2. Continuously seal side and end laps with tape.
- C. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
 2. Seal laps by rolling.
- D. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches over preceding felt.
 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
 2. Embed each felt in a solid mopping of hot roofing asphalt.
 3. Glaze coat completed surface with hot roofing asphalt.
 4. Apply hot roofing asphalt within plus or minus 25 deg F of equiviscous temperature.
- E. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with [joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows] [and with long joints continuous at right angle to flutes of decking].
 - a. Locate end joints over crests of decking.
 - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.
 - h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - i. Loosely lay base layer of insulation units over substrate.
 - j. Mechanically attach base layer of insulation [and substrate board] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation according to requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity].
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 2. Install upper layers of insulation [and tapered insulation] with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.

- h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - i. Loosely lay each layer of insulation units over substrate.
 - j. Adhere each layer of insulation to substrate using adhesive according to [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- D. Installation Over Wood and Wood Panel Decking:
- 1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to [wood] [wood panel] decks.
 - a. Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 2. Install base layer of insulation with [joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows].
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - e. Fill gaps exceeding 1/4 inch with insulation.
 - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - g. Loosely lay base layer of insulation units over substrate.
 - h. Mechanically attach base layer of insulation [**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to [wood] [wood panel] decks.
 - 1) Fasten insulation according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 3. Install upper layers of insulation [and tapered insulation] with joints of each layer offset not less than 12 inches from previous layer of insulation.

- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
- b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
- c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
- d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
- e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
- f. Fill gaps exceeding 1/4 inch with insulation.
- g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- h. Loosely lay each layer of insulation units over substrate.
- i. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

E. Installation Over Concrete Decks:

1. Install base layer of insulation with [joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows].
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - b. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - d. Fill gaps exceeding 1/4 inch with insulation.
 - e. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - f. Loosely lay base layer of insulation units over substrate.
 - g. Adhere base layer of insulation to [concrete roof deck] [vapor retarder] according to [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.

- 2) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 3) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 4) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
 2. Install upper layers of insulation **[and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay each layer of insulation units over substrate.
 - i. Adhere each layer of insulation to substrate using adhesive according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification]** **[SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- F. Installation Over Cementitious Wood-Fiber Decks:
1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to cementitious wood-fiber decks.
 - a. Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
 2. Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows]** **[end joints staggered not less than 12 inches in adjacent rows]**.
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

- b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - e. Fill gaps exceeding 1/4 inch with insulation.
 - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - g. Loosely lay base layer of insulation units over substrate.
 - h. Adhere base layer of insulation to slip sheet according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
3. Install upper layers of insulation [and tapered insulation] with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay each layer of insulation units over substrate.
 - i. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

- G. Installation Over Lightweight Insulating Concrete Decks:
1. Mechanically fasten vented base sheet to lightweight insulating concrete roof deck, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.
 - a. Fasten vented base sheet according to requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity].
 - b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.
 2. Install base layer of insulation with [joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows].
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - e. Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay base layer of insulation units over substrate.
 - i. Adhere base layer of insulation to vented base sheet according to [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
 3. Install upper layers of insulation [and tapered insulation] with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

- 1) Trim insulation so that water flow is unrestricted.
- f. Fill gaps exceeding 1/4 inch with insulation.
- g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- h. Loosely lay each layer of insulation units over substrate.
- i. Adhere each layer of insulation to substrate using adhesive according to [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- H. Place [thermal spacers and] plates on insulation in required fastening patterns [to achieve FM rating] and secure in accordance with manufacturer's instructions.
 1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

3.07 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 3. Cut and fit cover board tight to nailers, projections, and penetrations.
 4. Adhere cover board to substrate using adhesive according to [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- B. Install slip sheet over cover board and immediately beneath roof membrane.
- C. Place plates on insulation in required fastening patterns [to achieve FM rating] and secure in accordance with manufacturer's instructions.

1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

3.08 INSTALLATION OF ELD COMPONENTS

- A. Install conductive medium over [cover board] [insulation] [and on vertical locations to receive roof membrane] in accordance with manufacturer's written instructions.
- B. Install sensors, [wire loop] [conductive fabric], connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.09 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel [Owner's testing and inspection agency].
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
- G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- H. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- I. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.10 INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

- A. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.

- C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.
- D. Start installation of roofing in presence of roofing system manufacturer's technical personnel [and Owner's testing and inspection agency].
- E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- H. In-Seam Attachment: Secure one edge of PVC sheet using fastening plates or metal battens centered within seam, and mechanically fasten PVC sheet to roof deck.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.11 INSTALLATION OF INDUCTION-WELDED ROOF MEMBRANE

- A. Unroll roof membrane and allow to relax before installing.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel [and Owner's testing and inspection agency].
- C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer, with side laps shingled with slope of roof deck where possible.
- D. Seams: Clean seam areas, overlap roof membrane, and hot-air-weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity.
 - 2. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- E. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

- F. Induction-weld roof membrane to plates in accordance with roofing system manufacturer's written instructions, creating 100 percent bond between underside of membrane and top of plates; a partial bond is unacceptable.
 - 1. Test welds to verify adhesion of roof membrane to top of plates in accordance with membrane manufacturer's instructions.

3.12 INSTALLATION OF LOOSELY LAID AND BALLASTED ROOF MEMBRANE

- A. Loosely lay roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Comply with requirements in ANSI/SPRI RP-4 for [System 1] [System 2] [System 3].
- D. Start installation of roofing in presence of roofing system manufacturer's technical personnel [and Owner's testing and inspection agency].
- E. Accurately align roof membrane, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- F. Mechanically fasten or adhere perimeter of roofing according to requirements in ANSI/SPRI RP-4.
- G. [Mechanically fasten] [or] [adhere] roof membrane at corners, perimeters, and transitions according to requirements in ANSI/SPRI RP-4.
 - 1. At corners and perimeters, omit aggregate ballast leaving roof membrane exposed.
 - 2. At corners and perimeters, adhere a second layer of roof membrane.
- H. Apply roof membrane with side laps shingled with slope of deck where possible.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashing.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains and securely seal roof membrane in place with clamping ring.
- K. Install protection mat over roof membrane, overlapping a minimum of 6 inches. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches.
- L. Aggregate Ballast: Apply uniformly over roof membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roofing ballasted at end of workday.
 - 1. Ballast Weight:

- a. Size 4 aggregate, 10 lb/sq. ft..
 - b. Size 2 aggregate, 13 lb/sq. ft., at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft., elsewhere.
 - c. Size 2 aggregate, 13 lb/sq. ft..
 - d. Size 3 aggregate, <Insert weight>, at corners, <Insert weight> at perimeter, and <Insert weight>, elsewhere.
- M. Roof-Paver Ballast: Install [lightweight] [heavyweight] roof-paver ballast according to manufacturer's written instructions.
- N. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
1. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of 10 lb/sq. ft..
 2. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of 13 lb/sq. ft..
- 3.13 INSTALLATION OF BASE FLASHING
- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
 - B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
 - C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
 - D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
 - E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.14 INSTALLATION OF WALKWAYS

- A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.
 1. Install flexible walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions.

1. Install roof paver walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.
2. Provide 3 inches of space between adjacent roof pavers.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.

B. Perform the following tests:

1. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - a. Perform tests before overlying construction is placed.
 - b. Flood to an average depth of **[2-1/2 inches]** <Insert depth> with a minimum depth of **[1 inch]** <Insert depth> and not exceeding a depth of **[4 inches]** <Insert depth>. Maintain 2 inches of clearance from top of base flashing.
 - c. Flood each area for **[24]** **[48]** **[72]** hours.
 - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.
2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography according to ASTM C1153.
 - a. Perform tests before overlying construction is placed.
 - b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.

- c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.
 3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ASTM D7954/D7954M.
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.
 4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ANSI/SPRI/RCI NT-1.
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.
 5. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage **[horizontal membrane scanning platform] [membrane electric field vector mapping] [or] [vertical membrane scanning]** in accordance with ASTM D8231.
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.
 6. High-Voltage Membrane Testing: Testing agency surveys entire **[roof area,] [flashings,] [and] [parapet walls]** to locate discontinuity in the roof membrane using an electrically charged metal "broom head."
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.
 - 1) Cost of retesting is Contractor's responsibility.
 7. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.16 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.17 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: <Insert name of Owner>.
 - 2. Owner Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Building Address: <Insert address>.
 - 5. Area of Work: <Insert information>.
 - 6. Acceptance Date: _____.
 - 7. Warranty Period: <Insert time>.
 - 8. Expiration Date: _____.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert mph>;

- c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION

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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof-drainage sheet metal fabrications.
2. Low-slope roof sheet metal fabrications.
3. Steep-slope roof sheet metal fabrications.
4. Wall sheet metal fabrications.
5. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section <Insert Section number> "<Insert Section title>" for **[materials and installation]** of manufactured sheet metal through-wall flashing and trim integral with masonry.
3. Section <Insert Section number> "<Insert Section title>" for **[materials and installation]** of sheet metal flashing and trim integral with roofing.
4. Section <Insert Section number> "<Insert Section title>" for sheet metal flashing and trim integral with metal wall panels.
5. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
6. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
8. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
9. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies subject to vehicular traffic.

1.02 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Roof-drainage sheet metal fabrications.
2. Low-slope roof sheet metal fabrications.
3. Steep-slope roof sheet metal fabrications.
4. Wall sheet metal fabrications.
5. Miscellaneous sheet metal fabrications.

B. Product Data Submittals:

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.
4. Epoxy seam sealer.

C. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail formed flashing and trim at scale of not less than **[1-1/2 inches per 12 inches] [3 inches per 12 inches] <Insert scale>**.

- D. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
- E. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- F. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is **[ANSI/SPRI/FM 4435/ES-1 tested] [and] [FM Approvals approved]**.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For copings and roof edge flashing, from **[an agency acceptable to authority having jurisdiction] [ICC-ES] <Insert evaluation agency>** showing compliance with ANSI/SPRI/FM 4435/ES-1.
- E. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested **[and FM Approvals approved]**, shop is to be listed as able to fabricate required details as tested and approved.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof **[edge] [eave]**, including **[built-in gutter] [fascia] [fascia trim] [apron flashing] <Insert item>**, approximately **[10 feet] <Insert dimension>** long, including supporting construction cleats, seams, attachments, **[underlayment,]** and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.09 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: **[20] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers named within specification are approved for use on the Project providing:
 1. Their products meet or exceed the specifications.
 2. Company has a minimum of five (5) years' experience manufacturing products of the type specified.
 3. Products have been tested in conjunction with roofing membrane system as an assembly and as such has obtained the same approval and rating as the roofing membrane system.
 4. Products are approved for use by the roofing membrane manufacturer.

- B. Substitutions shall be in accordance with Division 01 requirements regarding substitutions.

2.02 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with [NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"] [and] [SMACNA's "Architectural Sheet Metal Manual"] requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. SPRI Wind Design Standard: Manufacture and install [copings] [roof edge flashings] tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
1. Design Pressure: [As indicated on Drawings] <Insert design pressure>.
- E. FM Approvals Listing: Manufacture and install [copings] [roof edge flashings] that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, [Class 1-60] [Class 1-75] [Class 1-90] [Class 1-105] [Class 1-120] <Insert class>. Identify materials with name of fabricator and design approved by FM Approvals.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change: [120 deg F, ambient; 180 deg F, material surfaces] <Insert temperature change>.

2.03 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.
1. Source Limitations: Obtain sheet from single source from single manufacturer.
 2. Nonpatinated, Exposed Finish: Mill.
 3. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA 500.
 - a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [waterborne,] [solvent-borne,] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of 1 mil.

- b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," **[waterborne,] [solvent-borne,]** air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of 1 mil.
 4. Prepatinated Copper-Sheet Finish: **[Dark brown] [Verdigris] <Insert color>**, prepatinated in accordance with ASTM B882.
- C. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with **[smooth, flat] [embossed]** surface.
 1. As-Milled Finish: **[Mill] [One-side bright mill] [Standard one-side bright] [Standard two-side bright]**.
 2. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
 3. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.
 4. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 5. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: **[Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>**.
 - b. Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
 6. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

- d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
7. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 8. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
- D. Stainless Steel Sheet: ASTM A240/A240M, **[Type 304]** **[Type 316]**, dead soft, fully annealed; with **[smooth, flat]** **[embossed]** surface.
1. Finish: **[ASTM A480/A480M, No. 2D (dull, cold rolled)]** **[ASTM A480/A480M, No. 2B (bright, cold rolled)]** **[ASTM A480/A480M, No. 3 (coarse, polished directional satin)]** **[ASTM A480/A480M, No. 4 (polished directional satin)]** <Insert finish>.
 - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1) Run grain of directional finishes with long dimension of each piece.
 - 2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- E. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper; coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).
1. Source Limitations: Obtain sheet from single source from single manufacturer.
- F. Metallic-Coated Steel Sheet: Provide **[zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, **G90** coating designation]** **[or]** **[aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, **Class AZ50** coating designation, **Grade 40**]**; prepainted by coil-coating process to comply with ASTM A755/A755M.
1. Surface: **[Smooth, flat]** **[Embossed]** **[and mill phosphatized for field painting]** **[and with manufacturer's standard clear acrylic coating on both sides]**.
 2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

- b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - c. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - d. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - e. FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
- 3. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
- G. Zinc Sheet: **[99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)]** **[Zinc, 99 percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum]**; with manufacturer's standard factory-applied, flexible, protective back coating.
- 1. Source Limitations: Obtain sheet from single source from single manufacturer.
 - 2. Finish: **[Bright rolled]** **[Preweathered gray]** **[Preweathered black]** <Insert finish>.
- H. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed Temper O61.
- 1. Source Limitations: Obtain sheet from single source from single manufacturer.
 - 2. Nonpatinated, Exposed Finish: Mill.
 - 3. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA 500.
- Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," **[waterborne,]** **[solvent-borne,]** methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of 1 mil.

Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," **[waterborne,] [solvent-borne,]** air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of 1 mil.

2.04 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.
 - 1. Source Limitations: Obtain underlayment from single source from single manufacturer.
- C. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
 - 1. Source Limitations: Obtain underlayment from single source from single manufacturer.
 - 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.
- D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.05 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners **[, solder]**, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal **[or manufactured item]** unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal **[or manufactured item]**.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.
 - 3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

5. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
 6. Fasteners for Zinc Sheet: Series 300 stainless steel [or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M].
- C. Solder:
1. For Copper or Copper-Clad Stainless Steel: ASTM B32, [Grade Sn50, 50 percent tin and 50 percent lead] [with maximum lead content of 0.2 percent].
 2. For Stainless Steel: ASTM B32, **[Grade Sn60] [Grade Sn96]**, with acid flux of type recommended by stainless steel sheet manufacturer.
 3. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
 4. For Zinc-Coated (Galvanized) Steel: ASTM B32, [Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead] [with maximum lead content of 0.2 percent].
 5. For Zinc: ASTM B32, [40 percent tin and 60 percent lead with low antimony,] [with maximum lead content of 0.2 percent,] as recommended by zinc manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric **[polyurethane] [polysulfide] [silicone]** polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.
- J. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated **[with factory-mitered and -welded corners and junctions] [and] [with interlocking counterflashing on exterior face, of same metal as reglet]**.
1. Source Limitations: Obtain reglets from single source from single manufacturer.
 2. Material: [Stainless steel, **0.0188 inch thick**] [Copper, **16 oz./sq. ft.**] [Aluminum, **0.024 inch thick**] [Galvanized steel, **0.022 inch thick**].
 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
8. Finish: [Mill] [With manufacturer's standard color coating] <Insert finish>.

2.06 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard [**and by FM Global Property Loss Prevention Data Sheet 1-49**] for application, but not less than thickness of metal being secured.
- G. Seams:
 - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. **[Rivet joints where necessary for strength.]**
 - 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. **[Rivet joints where necessary for strength.]**
- H. Do not use graphite pencils to mark metal surfaces.

2.07 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters:
 - 1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
 - 2. Fabricate in minimum 96-inch- long sections.
 - 3. Furnish flat-stock gutter brackets and **[flat-stock] [twisted]** gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than **[twice the gutter thickness] [dimension indicated on Drawings]** <Insert dimension>.
 - 4. Fabricate expansion joints, expansion-joint covers, **[gutter bead reinforcing bars,]** and gutter accessories from same metal as gutters. **[Shop fabricate interior and exterior corners.]**
 - 5. Gutter Profile: **[Style A] [Style B] [Style C] [Style D] [Style E] [Style F] [Style G] [Style H] [Style I] [Style J] [Style K] [Style L]** in accordance with cited sheet metal standard.
 - 6. Expansion Joints: **[Lap type] [Butt type] [Butt type with cover plate] [Built in].**
 - 7. Accessories: **[Continuous, removable leaf screen with sheet metal frame and hardware cloth screen] [Wire-ball downspout strainer] [Valley baffles].**
 - 8. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
 - a. Copper: **[16 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 - g. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.

9. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
 - a. Copper: **[16 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.040 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 - g. Zinc: **[0.039 inch] [0.048 inch]** <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
 10. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
 - a. Copper: **[20 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.050 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0250 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[20 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.034 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.034 inch]** <Insert dimension> thick.
 - g. Zinc: **[0.048 inch] [0.059 inch]** <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: **[0.027 inch]** <Insert dimension> thick.
 11. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
 - a. Copper: **[24 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.063 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0313 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[24 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.040 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.040 inch]** <Insert dimension> thick.
 12. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:
 - a. Copper: **[24 oz./sq. ft.]** <Insert value>.
 - b. Stainless Steel: **[0.0375 inch]** <Insert dimension> thick.
 - c. Zinc-Tin Alloy-Coated Copper: **[25 oz./sq. ft.]** <Insert value>.
 - d. Galvanized Steel: **[0.052 inch]** <Insert dimension> thick.
 - e. Aluminum-Zinc Alloy-Coated Steel: **[0.052 inch]** <Insert dimension> thick.
- B. Built-in Gutters:
1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

2. Fabricate in minimum 96-inch- long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
 3. Fabricate gutters with built-in expansion joints [**and gutter-end expansion joints at walls**].
 4. Accessories: [Continuous, removable leaf screen with sheet metal frame and hardware cloth screen] [Bronze wire-ball downspout strainer] [Wire-ball downspout strainer].
 5. Fabricate from the following materials:
 - a. Copper: [16 oz./sq. ft.] <Insert value>.
 - b. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 - c. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - d. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - e. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- C. Downspouts: Fabricate [round] [rectangular] [open-face] downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from [same material as downspouts and anchors] <Insert material>. [Shop fabricate elbows.]
1. Fabricated Hanger Style: [Fig. 1-35A] [Fig. 1-35B] [Fig. 1-35C] [Fig. 1-35D] [Fig. 1-35E] [Fig. 1-35F] [Fig. 1-35G] [Fig. 1-35H] [Fig. 1-35I] [Fig. 1-35J] in accordance with SMACNA's "Architectural Sheet Metal Manual."
 2. Manufactured Hanger Style: [Fig. 1-34A] [Fig. 1-34B] [Fig. 1-34C] [Fig. 1-34D] [Fig. 1-34E] in accordance with SMACNA's "Architectural Sheet Metal Manual."
 3. Hanger Style: <Insert description>.
 4. Fabricate from the following materials:
 - a. Copper: [16 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.024 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 - g. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- D. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. [**Fasten gravel guard angles to base of scupper.**] Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.

7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes **[, exterior flange trim,] [and] [built-in overflows]**. Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- F. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.040 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 6. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.

2.08 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long sections. Furnish with 6-inch- wide, joint cover plates. **[Shop fabricate interior and exterior corners.]**
1. Joint Style: **[Overlapped, 4 inches wide] [Butted with expansion space and 6-inch-wide, concealed backup plate] [Butted with expansion space and 6-inch- wide, exposed cover plate]** <Insert description>.
 2. Fabricate with scuppers spaced **[10 feet]** <Insert dimension> apart, to dimensions required with 4-inch- wide flanges and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
 3. Fabricate from the following materials:
 - a. Copper: **[20 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.050 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[20 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 - g. Zinc: **[0.048 inch] [0.059 inch]** <Insert dimension> thick.

- h. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and **[drill elongated holes for fasteners on]** interior leg. Miter corners, **[fasten and seal] [solder or weld]** watertight. **[Shop fabricate interior and exterior corners.]**
1. Coping Profile: **[Fig. 3-4A] [Fig. 3-4B] [Fig. 3-4C] [Fig. 3-4D] [Fig. 3-4E] [Fig. 3-4F] [Fig. 3-4G]** in accordance with SMACNA's "Architectural Sheet Metal Manual."
 2. Joint Style: **[Butted with expansion space and 6-inch- wide, concealed backup plate] [Butted with expansion space and 6-inch- wide, exposed cover plate]** <Insert description>.
 3. Fabricate from the following materials:
 - a. Copper: **[24 oz./sq. ft.]** <Insert value>.
 - b. Aluminum: **[0.050 inch]** <Insert dimension> thick.
 - c. Stainless Steel: **[0.0250 inch]** <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: **[24 oz./sq. ft.]** <Insert value>.
 - e. Galvanized Steel: **[0.040 inch]** <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: **[0.040 inch]** <Insert dimension> thick.
 - g. Zinc: **[0.048 inch] [0.059 inch]** <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: **[0.027 inch]** <Insert dimension> thick.
- C. Expansion-Joint Cover: **[Shop fabricate interior and exterior corners.]** Fabricate **[roof] [and] [roof-to-wall transition] [roof-to-roof edge-flashing (gravel-stop) transition] [roof-to-roof edge-flashing (gravel-stop) and fascia-cap transition]** expansion-joint cover from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.050 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0250 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.034 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.034 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.027 inch]** <Insert dimension> thick.
- D. Base Flashing: **[Shop fabricate interior and exterior corners.]** Fabricate from the following materials:
1. Copper: **[20 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.040 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[20 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.

7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- E. Counterflashing: **[Shop fabricate interior and exterior corners.]** Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- F. Flashing Receivers: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 4. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
 8. Lead: **[4 lb]** <Insert weight>.
- H. Roof-Drain Flashing: Fabricate from the following materials:
1. Copper: **[12 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 3. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.

2.09 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- B. Valley Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 4. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- C. Drip Edges: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- D. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.

- E. Counterflashing: **[Shop fabricate interior and exterior corners.]** Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- F. Flashing Receivers: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 4. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
 8. Lead: **[4 lb]** <Insert weight>.

2.10 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 4. Zinc: **[0.032 inch] [0.039 inch]** <Insert dimension> thick.

5. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, **[jamb,]** and similar flashings to extend **[4 inches]** <Insert dimension> beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.032 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0156 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.022 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.022 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch]** **[0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.016 inch]** <Insert dimension> thick.
- C. Wall Expansion-Joint Cover: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Aluminum: **[0.040 inch]** <Insert dimension> thick.
 3. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 5. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 7. Zinc: **[0.032 inch]** **[0.039 inch]** <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.

2.11 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
1. Copper: **[16 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0188 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[16 oz./sq. ft.]** <Insert value>.
 4. Galvanized Steel: **[0.028 inch]** <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: **[0.028 inch]** <Insert dimension> thick.
 6. Copper-Clad Stainless Steel: **[0.018 inch]** <Insert dimension> thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
1. Copper: **[24 oz./sq. ft.]** <Insert value>.
 2. Stainless Steel: **[0.0250 inch]** <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: **[24 oz./sq. ft.]** <Insert value>.
 4. Galvanized Steel: **[0.040 inch]** <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: **[0.040 inch]** <Insert dimension> thick.
 6. Copper-Clad Stainless Steel: **[0.027 inch]** <Insert dimension> thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
1. Verify compliance with requirements for installation tolerances of substrates.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
 2. Lap joints not less than 2 inches.
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
1. Lap horizontal joints not less than 4 inches.
 2. Lap end joints not less than 12 inches.
- C. Self-Adhering, High-Temperature Sheet Underlayment:
1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 2. Prime substrate if recommended by underlayment manufacturer.
 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
 6. Roll laps and edges with roller.
 7. Cover underlayment within 14 days.
- D. Install slip sheet, wrinkle free, **[over underlayment] [directly on substrate]** <Insert requirement> before installing sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
 2. Lapp joints not less than 4 inches.

3.03 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners **[, solder]**, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of **[solder] [welds] [sealant]**.
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
 6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of **[uncoated-aluminum] [and] [stainless steel]** sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of **[10 feet] <Insert dimension>** with no joints within 24 inches of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate **[wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws] [substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>**.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.

- a. Embed hooked flanges of joint members not less than 1 inch into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pretin edges of sheets with solder to width of 1-1/2 inches; however, reduce pretinning where pretinned surface would show in completed Work.
 2. Do not solder [metallic-coated steel] [and] [aluminum] sheet.
 3. Do not pretin zinc-tin alloy-coated copper.
 4. Do not use torches for soldering.
 5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
 6. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
 8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.
- H. Rivets: Rivet joints in [uncoated aluminum] [zinc] where necessary for strength.
- 3.04 INSTALLATION OF ROOF-DRAINAGE SYSTEM
- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
1. Join sections with [riveted and soldered joints] [or] [joints sealed with sealant].
 2. Provide for thermal expansion.
 3. Attach gutters at eave or fascia to firmly anchor them in position.
 4. Provide end closures and seal watertight with sealant.
 5. Slope to downspouts.
 6. Fasten gutter spacers to front and back of gutter.

7. Anchor and loosely lock back edge of gutter to continuous **[cleat] [eave or apron flashing]**.
 8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than **[24 inches] <Insert dimension>** apart.
 9. Anchor gutter with **[gutter brackets] [straps] [twisted straps]** spaced not more than **[24 inches] [30 inches] [36 inches] <Insert dimension>** apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
 10. Anchor gutter with spikes and ferrules spaced not more than **[24 inches] [30 inches] <Insert dimension>** apart.
 11. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, **[50 feet] <Insert dimension>** apart. Install expansion-joint caps.
 12. Install continuous gutter screens on gutters with noncorrosive fasteners, **[removable] [hinged to swing open]** for cleaning gutters.
- C. Built-in Gutters:
1. Join sections with **[riveted and soldered joints] [or] [joints sealed with sealant]**.
 2. Provide for thermal expansion.
 3. Slope to downspouts.
 4. Provide end closures and seal watertight with sealant.
 5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.
 - a. Lap sides minimum of 2 inches over underlying course.
 - b. Lap ends minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. Fasten with roofing nails.
 - e. Install slip sheet over underlayment.
 6. Anchor and loosely lock back edge of gutter to continuous **[cleat] [eave or apron flashing]**.
 7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than **[18 inches] <Insert dimension>** apart.
 8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, **[50 feet] <Insert dimension>** apart. Install expansion-joint caps.
- D. Downspouts:
1. Join sections with 1-1/2-inch telescoping joints.
 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 3. Locate hangers at top and bottom and at approximately 60 inches o.c.
 4. Provide elbows at base of downspout to direct water away from building.
 5. Connect downspouts to underground drainage system.
- E. Splash Pans:
1. Install where downspouts discharge on **[low-slope roofs] <Insert surface>**.

2. Set in **[asphalt roofing cement] [or] [elastomeric sealant]** compatible with the substrate.

F. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and **[solder] [or] [seal with elastomeric sealant]** to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. **[Solder] [or] [seal with elastomeric sealant]** exterior wall scupper flanges into back of conductor head.

G. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below **[scupper] [or] [gutter]** discharge.

H. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

3.05 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements **[, sheet metal manufacturer's written installation instructions,]** and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at **[staggered 3-inch] <Insert spacing>** centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at **[24-inch] [16-inch] <Insert dimension>** centers.
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at **[24-inch] <Insert dimension>** centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
 - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 - 2. Extend counterflashing 4 inches over base flashing.
 - 3. Lap counterflashing joints minimum of 4 inches.
 - 4. Secure in waterproof manner by means of [snap-in installation and sealant or lead wedges and sealant] [interlocking folded seam or blind rivets and sealant] [anchor and washer spaced at **12 inches** o.c. along perimeter and **6 inches** o.c. at corners areas] <Insert requirement> unless otherwise indicated.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with **[elastomeric]** **[butyl]** sealant and clamp flashing to pipes that penetrate roof.

3.06 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, **[jamb,]** and similar flashings to extend **[4 inches]** <Insert dimension> beyond wall openings.
- C. Reglets: Installation of reglets is specified in Section 033000 "Cast-in-Place Concrete." Section 042200 "Concrete Unit Masonry." **[Section <Insert Section number> "<Insert Section title>".]**

3.07 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
 - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
 - 2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
 - 1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
 - 2. Pipe and install drain line to plumbing waste or drainage system.

3.08 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.09 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.10 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

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SECTION 07 71 00
ROOF SPECIALTIES

PART 1 GENERAL

A. Section Includes:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.
4. Reglets and counterflashings.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for downspout guards and downspout boots.
2. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 07 41 13.13 "Formed Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
4. Section 07 41 13.16 "Standing-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
5. Section 07 41 13.19 "Batten-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
6. Section 07 41 16 "Insulated Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
7. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
8. Section 07 71 29 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.
9. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
10. Section 07 72 53 "Snow Guards" for manufactured snow guard devices.
11. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
 2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.
- A. Product Data:
1. Copings.
 2. Roof-edge specialties.
 3. Roof-edge drainage systems.
 4. Reglets and counterflashings.
- B. Product Data Submittals: For each product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: For roof specialties.
1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
 2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 4. Detail termination points and assemblies, including fixed points.
 5. Include details of special conditions.
- D. Samples: For each type of roof specialty, each color and texture specified.
- E. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
- F. Samples for Verification:
1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
 2. Include **[copings] [roof-edge specialties] [roof-edge drainage systems] [reglets and counterflashings]** made from 12-inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For **[copings] [and] [roof-edge flashings]**, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.
- A. Maintenance Data: For roofing specialties to include in maintenance manuals.
- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are **[FM Approvals listed for specified class] [and] [SPRI ES-1 tested to specified design pressure]**.
- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof edge as indicated on Drawings.
 - 2. Build mockup of typical roof edge as part of Integrated Exterior Mockup specified in Section 01 40 00 "Quality Requirements"
 - 3. Build mockup of typical roof edge, including **[fascia] [gutter] [and] [downspout] <Insert item>**, approximately **[10 feet] <Insert dimension>** long, including supporting construction, seams, attachments, **[underlayment,]** and accessories.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.
- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section **<Insert Section number> "<Insert roof Section title>."**
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. **Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.**
 - b. **Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.**
 - c. **Cracking, checking, peeling, or failure of paint to adhere to bare metal.**
2. Finish Warranty Period: **[20] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

- A. Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section **<Insert Section number and title>**.
- A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. FM Approvals' Listing: Manufacture and install **[copings] [roof-edge specialties]** that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, **[Class 1-60] [Class 1-75] [Class 1-90] [Class 1-105] [Class 1-120] <Insert class>**. Identify materials with FM Approvals' markings.
- C. SPRI Wind Design Standard: Manufacture and install **[copings] [roof-edge specialties]** tested in accordance with SPRI ES-1 and capable of resisting the following design pressures:
 1. Design Pressure: **[As indicated on Drawings] <Insert design pressure>**.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): **[120 deg F, ambient; 180 deg F] <Insert temperature range>**, material surfaces.
- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding **[12 feet] <Insert dimension>**, concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
 1. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal **[0.028-inch thickness] [0.034-inch thickness] [thickness as required to meet performance requirements] <Insert thickness>**.
 - a. **Surface: [Smooth, flat] [Embossed] finish.**
 - b. **Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>**.

- c. **Color:** [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
2. Formed Aluminum Sheet Coping Caps: Aluminum sheet, [0.040 inch thick] [0.050 inch thick] [0.063 inch thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Surface:** [Smooth, flat] [Embossed] finish.
 - b. **Finish:** [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. **Color:** [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
3. Extruded-Aluminum Coping Caps: Extruded aluminum, [0.080 inch thick] [0.125 inch thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Finish:** [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - b. **Color:** [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
4. Formed Stainless Steel Sheet Coping Caps: Stainless steel sheet, nominal [0.0313-inch thickness] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Finish:** [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)] <Insert finish>.
5. Formed Copper Sheet Coping Caps: Copper sheet, [20 oz./sq. ft. thick] [weight as required to meet performance requirements] <Insert weight>.
 - a. **Copper Finish:** [Non-patinated, mill] [Pre-patinated dark brown] [Pre-patinated verdigris] <Insert finish>.
6. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
7. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose-face leg] [Two-way sloped coping cap] <Insert description>.
8. Coping-Cap Attachment Method: [Snap-on] [or] [face leg hooked to continuous cleat with back leg fastener exposed], fabricated from coping-cap material.
 - a. **Snap-on Coping Anchor Plates:** Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.

- b. Face-Leg Cleats: Concealed, continuous [galvanized-steel sheet] [stainless steel].**
- A. Canted Roof-Edge Fascia and Gravel Stop <Insert drawing designation>: Manufactured, two-piece, roof-edge fascia consisting of **[snap-on] [compression-clamped]** metal fascia cover in section lengths not exceeding **[12 feet]** <Insert dimension> and a continuous formed galvanized-steel sheet cant, 0.028 inch thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.
1. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal **[0.028-inch thickness] [0.034-inch thickness] [thickness as required to meet performance requirements]** <Insert thickness>.
 - a. **Surface: [Smooth, flat] [Embossed] finish.**
 - b. **Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.**
 - c. **Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**
 2. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, **[0.040 inch thick] [0.050 inch thick] [0.063 inch thick] [thickness as required to meet performance requirements]** <Insert thickness>.
 - a. **Surface: [Smooth, flat] [Embossed] finish.**
 - b. **Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.**
 - c. **Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**
 3. Extruded-Aluminum Fascia Covers: Extruded aluminum, **[0.080 inch thick] [0.125 inch thick] [thickness as required to meet performance requirements]** <Insert thickness>.
 - a. **Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.**
 - b. **Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**
 4. Corners: Factory mitered and **[soldered] [continuously welded] [mechanically clinched and sealed watertight]**.
 5. Splice Plates: **[Concealed] [Exposed]**, of same material, finish, and shape as fascia cover.

6. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose fascia cover] [Cornice fascia cover] [Cove fascia cover] <Insert description>.
 7. Fascia Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] [Overflow scuppers] [Overflow scuppers with perforated screens] [Spillout scuppers] [Downspout scuppers with integral conductor head and downspout adapters] [Downspout scuppers with integral conductor head and downspout adapters and perforated screens] <Insert description>.
- B. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding **[12 feet]** <Insert dimension> and a continuous metal receiver with integral drip-edge cleat to engage fascia cover **[and secure single-ply roof membrane]**. Provide matching corner units.
1. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal **[0.028-inch thickness]** **[0.034-inch thickness]** [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Surface:** [Smooth, flat] [Embossed] finish.
 - b. **Finish:** [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. **Color:** [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 2. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, **[0.040 inch thick]** **[0.050 inch thick]** **[0.063 inch thick]** [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Surface:** [Smooth, flat] [Embossed] finish.
 - b. **Finish:** [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. **Color:** [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 4. Splice Plates: **[Concealed]** **[Exposed]**, of same material, finish, and shape as fascia cover.
 5. Receiver: [Galvanized-steel sheet, nominal **0.040-inch** thickness] [Aluminum sheet, **0.050 inch** thick] [Extruded aluminum, **0.080 inch** thick] [Manufacturer's standard material and thickness].
 6. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose fascia cover] [Cornice fascia cover] [Cove fascia cover] <Insert description>.

7. Fascia Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] [Overflow scuppers] [Overflow scuppers with perforated screens] [Spillout scuppers] [Downspout scuppers with integral conductor head and downspout adapters] [Downspout scuppers with integral conductor head and downspout adapters and perforated screens] <Insert description>.
- C. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding **[12 feet]** <Insert dimension>, with a horizontal flange and vertical leg [, **drain-through**] fascia [**terminating in a drip edge**], and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
1. Retain one of five metal gravel stops subparagraphs below. Retain thickness of gravel stop that meets performance requirements and has the rigidity to suit Project.
 2. Metallic-Coated Steel Sheet Gravel Stops: Zinc-coated (galvanized) steel, nominal **[0.028-inch thickness]** **[0.034-inch thickness]** [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Surface:** [Smooth, flat] [Embossed] finish.
 - b. **Finish:** [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. **Color:** [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Formed Aluminum Sheet Gravel Stops: Aluminum sheet, **[0.040 inch thick]** **[0.050 inch thick]** **[0.063 inch thick]** [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Surface:** [Smooth, flat] [Embossed] finish.
 - b. **Finish:** [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. **Color:** [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 4. Extruded-Aluminum Gravel Stops: Extruded aluminum, **[0.080 inch thick]** **[0.125 inch thick]** [thickness as required to meet performance requirements] <Insert thickness>.
 - a. **Finish:** [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - b. **Color:** [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 5. Formed Stainless Steel Sheet Gravel Stops: Stainless steel sheet, nominal **[0.0313-inch thickness]** [thickness as required to meet performance requirements] <Insert thickness>.

- a. **Finish:** [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)] <Insert finish>.
6. Formed Copper Sheet Gravel Stops: Copper sheet, [20 oz./sq. ft.] [weight as required to meet performance requirements] <Insert weight>.
- a. **Copper Finish:** [Non-patinated, mill] [Pre-patinated dark brown] [Pre-patinated verdigris] <Insert finish>.
7. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
8. Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] <Insert description>.
- A. Gutters: Manufactured in uniform section lengths not exceeding [12 feet] <Insert dimension>, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
- 1. Zinc-Coated Steel: Nominal [0.028-inch] [0.034-inch] <Insert value> thickness.
 - 2. Aluminum Sheet: [0.032 inch] [0.040 inch] [0.050 inch] [0.063 inch] <Insert value> thick.
 - 3. Copper Sheet: [16 oz./sq. ft.] [20 oz./sq. ft.] <Insert value>.
 - 4. Gutter Profile: [Style A] [Style B] [Style F] [Style G] [Style H] [Style I] [Style K] [Style K highback] [Half-round single bead] [Half-round highback] [Quarter round] [Ogee] [As indicated] <Insert style> in accordance with SMACNA's "Architectural Sheet Metal Manual."
 - 5. Embossed Surface: Embossed with design [as indicated by manufacturer's designations] [As selected by Architect from manufacturer's full range] <Insert description>.
 - 6. Applied Fascia Cover (Concealed Gutter): Exposed, formed [copper, 16 oz./sq. ft.] [aluminum, 0.040 inch thick] <Insert material and weight or thickness>, with factory-mitered corners, ends, and concealed splice joints.
 - 7. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 - 8. Gutter Supports: [Gutter brackets] [Straps] [Spikes and ferrules] [Manufacturer's standard supports as selected by Architect] <Insert description> with finish matching the gutters.
 - 9. Special Fabrications: [Radiussed sections] <Insert description>.
 - 10. Gutter Accessories: [Continuous screened leaf guard with sheet metal frame] [Continuous hinged leaf guard of solid metal designed to shed leaves] [Continuous snap-in plastic leaf guard] [Bronze wire ball downspout strainer] [Wire ball downspout strainer] [Flat ends] [Bullnose ends for half-round gutter] <Insert description>.

- B. Downspouts: [Plain round] [Corrugated round] [Plain rectangular] [Corrugated rectangular] [Open-face rectangular] <Insert shape> complete with [machine-crimped] [mitered] [smooth-curve] elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Zinc-Coated Steel: Nominal [0.028-inch] [0.034-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch] [0.040 inch] [0.050 inch] [0.063 inch] <Insert value> thick.
 3. Extruded Aluminum: [0.125 inch] <Insert value> thick.
 4. Copper: [16 oz./sq. ft.] <Insert value>.
- C. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. [**Fasten gravel guard angles to base of scuppers.**]
1. Zinc-Coated Steel: Nominal [0.028-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch] <Insert value> thick.
 3. Stainless Steel: [0.0188 inch] <Insert value> thick.
 4. Copper: [16 oz./sq. ft.] <Insert weight>.
- D. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout [, exterior flange trim,] [and] [built-in overflow].
1. Zinc-Coated Steel: Nominal [0.028-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch] <Insert value> thick.
 3. Stainless Steel: [0.0156 inch] <Insert value> thick.
 4. Copper: [16 oz./sq. ft.] <Insert weight>.
- E. Splash Pans: Fabricate from the following exposed metal:
1. Zinc-Coated Steel: Nominal [0.028-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.040 inch] <Insert value> thick.
 3. Stainless Steel: [0.0188 inch] <Insert value> thick.
 4. Copper: [16 oz./sq. ft.] <Insert weight>.
- F. Zinc-Coated Steel Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

- G. Aluminum Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- H. Stainless Steel Finish: [ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)] <Insert finish>.
- I. Copper Finish: [Non-patinated, mill] [Pre-patinated dark brown] [Pre-patinated verdigris] <Insert finish>.
- A. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
1. Zinc-Coated Steel: Nominal [0.022-inch] [0.028-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.024 inch] [0.050 inch] <Insert value> thick.
 3. Stainless Steel: [0.0188 inch] [0.0250 inch] <Insert value> thick.
 4. Copper: [16 oz./sq. ft.] <Insert weight>.
 5. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 6. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 7. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 8. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 9. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
 10. Multiuse Type, Embedded: For multiuse embedment in [cast-in-place concrete] [masonry mortar joints].
- B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding [12 feet] <Insert dimension> designed to snap into [reglets] [or] [through-wall-flashing receiver] and compress against base flashings with joints lapped, from the following exposed metal:
1. Zinc-Coated Steel: Nominal [0.022-inch] [0.028-inch] <Insert value> thickness.
 2. Formed Aluminum: [0.024 inch] [0.032 inch] <Insert value> thick.

3. Stainless Steel: **[0.0188 inch] [0.0250 inch]** <Insert value> thick.
 4. Copper: **[16 oz./sq. ft.]** <Insert weight>.
- C. Accessories:
1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- D. Zinc-Coated Steel Finish: **[Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer]** <Insert finish>.
1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.
- E. Aluminum Finish: **[Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic]** <Insert finish>.
1. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.
- F. Stainless Steel Finish: **[ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)]** <Insert finish>.
- G. Copper Finish: **[Non-patinated, mill] [Pre-patinated verdigris]** <Insert finish>.
- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
- B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.
- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F (116 deg C).
 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F.

- B. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. minimum.
- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 - 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 - 2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 - 3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 - 4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 - 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric **[polyurethane]** **[silicone]** polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.
- F. Solder for Copper: ASTM B32, **[lead-free solder]** **[Grade Sn50, 50 percent tin and 50 percent lead]** **<Insert solder grade>**.
- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Coil-Coated Galvanized-Steel Sheet Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.

- a. **Two-Coat Fluoropolymer: AAMA 621.** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
- b. **Three-Coat Fluoropolymer: AAMA 621.** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
- c. **Two-Coat Mica Fluoropolymer: AAMA 621.** Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
- d. **Three-Coat Metallic Fluoropolymer: AAMA 621.** Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
- e. **Concealed Surface Finish:** Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

E. Coil-Coated Aluminum Sheet Finishes:

1. **High-Performance Organic Finish:** Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. **Two-Coat Fluoropolymer: AAMA 2605.** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - b. **Three-Coat Fluoropolymer: AAMA 2605.** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - c. **Two-Coat Mica Fluoropolymer: AAMA 2605.** Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].

- d. **Three-Coat Metallic Fluoropolymer: AAMA 2605.** Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - e. **Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.**
2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 3. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
- F. Aluminum Extrusion Finishes:
1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. **Two-Coat Fluoropolymer: AAMA [2604] [2605].** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. **Three-Coat Fluoropolymer: AAMA [2604] [2605].** Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. **Two-Coat Mica Fluoropolymer: AAMA [2604] [2605].** Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - d. **Three-Coat Metallic Fluoropolymer: AAMA [2604] [2605].** Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - e. **Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.**
 2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 3. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.

G. Copper Sheet Finishes:

1. Non-Patinated Finish: Mill finish.
2. Pre-Patinated Finish: Chemically treated in accordance with ASTM B882.

PART 3 EXECUTION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
 1. Apply continuously under [copings] [roof-edge specialties] [and] [reglets and counterflashings].
 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 4. Torch cutting of roof specialties is not permitted.
 5. Do not use graphite pencils to mark metal surfaces.

- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of **[uncoated aluminum] [and] [stainless steel]** roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of **[12 feet] <Insert dimension>** with no joints within **[18 inches] <Insert dimension>** of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate **[wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws] [substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>**.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at **[30-inch centers] [40-inch centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**.
 2. Interlock face-leg drip edge into continuous cleat anchored to substrate at **[24-inch centers] [16-inch centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**. Anchor back leg of coping with screw fasteners and elastomeric washers at **[24-inch centers] [16-inch centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**.

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
- A. Install components to produce a complete roof-edge drainage system in accordance with manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than **[12 inches] [24 inches] [30 inches] <Insert dimension>** apart. Attach ends with rivets and **[seal with sealant] [solder]** to make watertight. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding **[50 feet] <Insert dimension>** apart. Install expansion-joint caps.
 - 2. Install continuous leaf guards on gutters with noncorrosive fasteners, **[removable] [hinged to swing open]** for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately **[60 inches] <Insert dimension>** o.c.
 - 1. Provide elbows at base of downspouts at grade to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.
- D. Splash Pans: Install where downspouts discharge on **[low-slope roofs] <Insert surface>**. Set in **[asphalt roofing cement] [elastomeric sealant]**.
- E. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Seal or solder exterior wall scupper flanges into back of conductor head.
- F. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below **[scupper] [gutter]** discharge.
- A. Coordinate installation of reglets and counterflashings with installation of base flashings.
- B. Embedded Reglets: See **[Section 03 30 00 "Cast-in-Place Concrete"] [and] [Section 04 22 00 "Concrete Unit Masonry"]** for installation of reglets.
- C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.

- D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.
- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Heat and smoke vents.
5. Gravity ventilators.
6. Pipe and duct supports.
7. Pipe portals.
8. Preformed flashing sleeves.
9. Roof walkways.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 055213 "Pipe and Tube Railings" for safety railing systems not attached to roof-hatch curbs.
3. Section 076100 "Sheet Metal Roofing" for shop- and field-formed roof curbs and snow guards for sheet metal roofing.
4. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
5. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.
6. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.
7. Section 077253 "Snow Guards" for snow guards.

8. Section 086200 "Unit Skylights" for single- and double-glazed domed plastic skylights with curb frame.
9. Section 230548 "Vibration and Seismic Controls for HVAC" for special curbs designed to accommodate seismic and vibration controls.
10. Section 233423 "HVAC Power Ventilators" for power roof-mounted ventilators.
11. Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units" for standard curbs specified with rooftop units.
12. **[Section 284621.11 "Addressable Fire-Alarm Systems"] [Section 28462.13 "Conventional Fire-Alarm Systems"]** for interconnects to automatically operate heat and smoke vents.

1.02 COORDINATION

- A. Coordinate layout and installation of roof accessories with **[roofing membrane and base flashing and] interfacing** and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.
- D. Delegated Design Submittals: For **[roof curbs] [equipment supports] [and] [walkways]** indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
 2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.06 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: **[20] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers listed in other Part 2 articles.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **[roof curbs] [and] [equipment supports]** to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: **[As indicated on Drawings] <Insert requirements>**.

2.03 ROOF CURBS

- A. Roof Curbs: Provide metal roof curbs, internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, **[straight sides,] [integral metal cant,] [stepped integral metal cant raised the thickness of roof insulation,]** and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers (Butler IF Curb):
 - a. Colony Custom Curbs.
 - b. Commodity Products Company, Inc.
 - c. Conn-Fab Sales, Inc.
 - d. Curbs Plus Inc.
 - e. Custom Curb, Inc.
 - f. LM Curbs.
 - g. Loren Cook Company.
 - h. Metallic Products Corporation.
 - i. Pate Company (The).
 - j. Roof Products & Systems Corporation.
 - k. Roof Products, Inc.
 - l. Thaler Metal Industries Ltd.
 - m. ThyCurb; Div. of Thybar Corporation.
 - n. Uni-Curb, Inc.
 - o. Vent Products Company, Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: **[Coordinate load capacity with information on Shop Drawings of equipment to be supported] <Insert load requirements>**.
- D. Steel: **[Zinc-coated (galvanized)] [Aluminum-zinc alloy-coated] steel sheet, [0.052 inch] [0.064 inch] [0.079 inch] <Insert dimension> thick.**
1. Finish: **[Mill phosphatized] [Factory prime coating] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>**.
 2. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.
- E. Aluminum: **[0.090 inch] [0.125 inch] <Insert dimension> thick sheet.**
1. Finish: **[Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>**.
 2. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>**.

- F. Stainless Steel: **[0.0781 inch]** <Insert dimension> thick sheet.
1. Finish: **[Manufacturer's standard]** **[ASTM A480/A480M, No. 2D, directional polish finish]** <Insert finish>.
- G. Construction:
1. Curb Profile: **[Manufacturer's standard]** **[Profile as indicated on Drawings]** compatible with roofing system.
 2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 3. Fabricate curbs to minimum height of **[12 inches]** <Insert dimension> above roofing surface unless otherwise indicated.
 4. Top Surface: Level top of curb, with roof slope accommodated **[by sloping deck-mounting flange]** **[or]** **[by use of leveler frame]**.
 5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 6. Insulation: Factory insulated with **[1-1/2-inch-]** <Insert dimension> thick glass-fiber board insulation.
 7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 8. Nailer: Factory-installed wood nailer **[along top flange of curb]** **[under top flange on side of curb]**, continuous around curb perimeter.
 9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
 10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
 12. Security Grille: **[Provide for all units]** **[Provide where indicated]**.
 13. Damper Tray: Provide damper tray or shelf with opening **[3 inches]** <Insert dimension> **[less than interior curb dimensions indicated]** **[of size indicated]**.

2.04 EQUIPMENT SUPPORTS

- A. Equipment Supports: **[Internally reinforced perimeter]** **[Rail-type]** metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded **[or mechanically fastened and sealed]** corner joints, **[integral metal cant,]** **[stepped integral metal cant raised the thickness of roof insulation,]** and integrally formed structure-mounting flange at bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: **[Coordinate load capacity with information on Shop Drawings of equipment to be supported]** <Insert load requirements>.
- D. Steel: **[Zinc-coated (galvanized)]** **[Aluminum-zinc alloy-coated]** steel sheet, **[0.052 inch]** **[0.064 inch]** **[0.079 inch]** <Insert dimension> thick.
1. Finish: **[Mill phosphatized]** **[Factory prime coating]** **[Two-coat fluoropolymer]** **[Baked enamel or powder coat]** <Insert finish>.
 2. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
- E. Aluminum: **[0.090 inch]** **[0.125 inch]** <Insert dimension> thick sheet.
1. Finish: **[Mill]** **[Factory prime coating]** **[Clear anodic]** **[Color anodic]** **[Two-coat fluoropolymer]** **[Baked enamel or powder coat]** <Insert finish>.
 2. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **[Light bronze]** **[Medium bronze]** **[Dark bronze]** <Insert color>.
- F. Stainless Steel: **[0.0781 inch]** <Insert dimension> thick sheet.
1. Finish: **[Manufacturer's standard]** **[ASTM A480/A480M, No. 2D, directional polish finish]** <Insert finish>.
- G. Construction:
1. Curb Profile: **[Manufacturer's standard]** **[Profile as indicated on Drawings]** compatible with roofing system.
 2. Insulation: Factory insulated with **[1-1/2-inch-]** <Insert dimension> thick glass-fiber board insulation.
 3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
 4. Nailer: Factory-installed continuous wood nailers **[3-1/2 inches]** **[5-1/2 inches]** <Insert dimension> wide **[on top flange of equipment supports]** **[under top flange on side of curb]**, continuous around support perimeter.

5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
9. Fabricate equipment supports to minimum height of **[12 inches]** <Insert dimension> above roofing surface unless otherwise indicated.
10. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.
11. Security Grille: **[Provide for all units]** **[Provide where indicated on Drawings]**.

2.05 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated **[single]** **[double]**-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, **[straight sides,]** **[integral metal cant,]** **[stepped integral metal cant raised the thickness of roof insulation,]** and integrally formed deck-mounting flange at perimeter bottom.
- B. Type and Size:
 1. Single-leaf lid, **[30 by 36 inches]** **[36 by 36 inches]** **[30 by 54 inches]** **[30 by 96 inches]** <Insert dimensions>.
 2. Double-leaf lid, **[72 by 96 inches]** <Insert dimensions>.
- C. Loads: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[20-lbf/sq. ft.]** <Insert value> internal uplift load.
 1. Dome Glazing: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[20-lbf/sq. ft.]** <Insert value> internal uplift load.
- D. Hatch Material, Steel: **[Zinc-coated (galvanized)]** **[Aluminum-zinc alloy-coated]** steel sheet.
 1. Thickness: **[Manufacturer's standard thickness for hatch size indicated]** **[0.079 inch]** <Insert dimension>.
 2. Finish: **[Mill phosphatized]** **[Factory prime coating]** **[Two-coat fluoropolymer]** **[Baked enamel or powder coat]** <Insert finish>.
 3. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.

E. Hatch Material, Aluminum:

1. Thickness: [Manufacturer's standard thickness for hatch size indicated] **[0.079 inch]** <Insert dimension>.
2. Finish: [Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.
3. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>.

F. Hatch Material, Stainless Steel:

1. Thickness: [Manufacturer's standard thickness for hatch size indicated] **[0.0781 inch]** <Insert dimension>.
2. Finish: [Manufacturer's standard] [ASTM A480/A480M, No. 2D, directional polish finish] <Insert finish>.

G. Construction:

1. Insulation: **[1-inch- thick, cellulosic-fiber board]** **[1-inch- thick, glass-fiber board]** **[2-inch- thick, polyisocyanurate board]**.
 - a. R-Value: **[2.78]** **[4.3]** **[12.0]** <Insert R-value> according to ASTM C1363.
2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: **[Opaque]** **[Glazed]**, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Fabricate curbs to minimum height of **[12 inches]** <Insert dimension> above roofing surface unless otherwise indicated.
7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is **[constant]** **[tapered to accommodate roof slope so that top surfaces of perimeter curb are level]**. Equip hatch with water diverter or cricket on side that obstructs water flow.

H. Hatch-Lid Glazing: **[Single]** **[Double]** **[acrylic]** **[polycarbonate]** glazing of thickness capable of resisting indicated loads.

1. Single-Dome Color: [Colorless, transparent] [White, translucent] [Gray tinted, transparent] [Bronze tinted, transparent] <Insert requirement>.
2. Outer Double-Dome Color: [Colorless, transparent] [White, translucent] [Gray tinted, transparent] [Bronze tinted, transparent] <Insert requirement>.
3. Inner Double-Dome Color: [Colorless, transparent] [White, translucent] [Gray tinted, transparent] [Bronze tinted, transparent] <Insert requirement>.

- I. Hardware: Spring operators, hold-open arm, **[galvanized] [stainless]** steel spring latch with turn handles, **[galvanized] [stainless]** steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
1. Provide two-point latch on lids larger than 84 inches.
 2. Provide remote-control operation.
- J. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
1. Height: **[42 inches]** <Insert dimension> above finished roof deck.
 2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
 3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
 5. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
 6. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 7. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 8. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 9. Fabricate joints exposed to weather to be watertight.
 10. Fasteners: Manufacturer's standard, finished to match railing system.
 11. Finish: **[Manufacturer's standard]** <Insert finish>.
 - a. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.
- K. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
 2. Height: **[42 inches]** <Insert dimension> above finished roof deck.
 3. Material: **[Steel tube] [Stainless steel] [Aluminum]**.
 4. Post: **[1-5/8-inch-]** <Insert dimension> diameter pipe.

5. Finish: [Manufacturer's standard baked enamel or powder coat] <Insert finish>.
 - a. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

2.06 HEAT AND SMOKE VENTS

- A. Hatch-Type Heat and Smoke Vents: Manufacturer's standard, with **[single]** **[double]**-walled insulated curbs, welded or mechanically fastened and sealed corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms and UL-listed **[fusible links rated at 165 deg F]** <Insert temperature rating> **[fire-suppression system]** **[smoke-detection system]**.

1. Type and Size:
 - a. Single-leaf lid, [size as indicated on Drawings] **[30 by 36 inches]** **[30 by 54 inches]** **[30 by 96 inches]** <Insert dimensions>.
 - b. Double-leaf lid, **[72 by 96 inches]** <Insert dimensions>.
2. Loads: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[30-lbf/sq. ft.]** <Insert value> internal uplift load.
 - a. When release is actuated, lid to open against **[10-lbf/sq. ft.]** <Insert value> snow or wind load and lock in position.
 - b. Hatch-Lid Glazing: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[20-lbf/sq. ft.]** <Insert value> internal uplift load.
3. Heat and Smoke Vent Standard: Provide units that have been tested and **[listed to comply with UL 793]** **[and]** **[are FM Approved]**.
4. Curb, Framing, and Lid Material, Steel: **[Zinc-coated (galvanized)]** **[Aluminum-zinc alloy-coated]** steel sheet.
 - a. Thickness: [Manufacturer's standard thickness for hatch size indicated] **[0.079 inch]** <Insert dimension>.
 - b. Finish: [Mill phosphatized] [Factory prime coating] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
5. Curb, Framing, and Lid Material, Aluminum:
 - a. Thickness: [Manufacturer's standard thickness for hatch size indicated] **[0.079 inch]** <Insert dimension>.
 - b. Finish: [Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>.
6. Construction:
 - a. Insulation: **[1-inch-** thick, cellulosic-fiber board] **[or]** **[1-inch-** thick, glass-fiber board] **[2-inch-** thick, polyisocyanurate board].

- 1) R-Value: **[2.78] [4.3] [12.0]** <Insert R-value> according to ASTM C1363.
 - b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 - c. Hatch Lid: **[Opaque] [Glazed]**, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 - d. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - e. Fabricate curbs to minimum height of **[12 inches]** <Insert dimension> above roofing surface unless otherwise indicated.
 - f. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is **[constant] [tapered to accommodate roof slope so that top surfaces of perimeter curb are level]**. Equip hatch with water diverter or cricket on side that obstructs water flow.
 - g. Security Grille: **[Provide for all units] [Provide where indicated on Drawings]**.
7. Hatch-Lid Glazing: **[Single] [Double] [acrylic] [polycarbonate]** glazing of thickness capable of resisting indicated loads; **[colorless, transparent] [white, translucent]** <Insert color requirement>.
 8. Hardware: Manufacturer's standard **[corrosion resistant] [stainless steel]**; with hinges, hold-open devices, and independent manual-release devices for **[inside] [and] [outside]** operation of lids.
- B. Dropout-Type Heat and Smoke Vents: Manufacturer's standard, gravity operated and automatic; with **[single] [double]**-walled insulated curbs and frame, welded or mechanically fastened and sealed corner joints, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening according to heat and smoke vent standard indicated.
1. Size: **[As indicated on Drawings] [48 by 48 inches] [48 by 60 inches] [48 by 72 inches] [48 by 90 inches] [48 by 96 inches]** <Insert dimensions>.
 2. Loads: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[30-lbf/sq. ft.]** <Insert value> internal uplift load.
 - a. Dome Glazing: Minimum **[40-lbf/sq. ft.]** <Insert value> external live load and **[20-lbf/sq. ft.]** <Insert value> internal uplift load.
 3. Heat and Smoke Vent Standard: Provide units that have been tested and **[listed to comply with UL 793] [and] [are FM Approved]**.
 4. Curb and Framing Material: Aluminum sheet.
 - a. Thickness: **[Manufacturer's standard thickness for vent size indicated] [0.079 inch]** <Insert dimension>.
 - b. Finish: **[Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat]** <Insert finish>.
 - c. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze]** <Insert color>.
 5. Construction:

- a. Insulation: Manufacturer's standard.
 - b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 - c. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - d. Fabricate curbs to minimum height of **[12 inches]** <Insert dimension> above roofing surface unless otherwise indicated.
 - e. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb with perimeter curb height that is **[constant]** **[tapered to accommodate roof slope so that top surfaces of perimeter curb are level]**. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Dome Glazing: **[Single]** **[Double]** **[acrylic]** **[polycarbonate]** glazing of thickness capable of resisting indicated loads.
 - a. Single-Dome Color: **[Colorless, transparent]** **[White, translucent]** **[Gray tinted, transparent]** **[Bronze tinted, transparent]** <Insert requirement>.
 - b. Outer Double-Dome Color: **[Colorless, transparent]** **[White, translucent]** **[Gray tinted, transparent]** **[Bronze tinted, transparent]** <Insert requirement>.
 - c. Inner Double-Dome Color: **[Colorless, transparent]** **[White, translucent]** **[Gray tinted, transparent]** **[Bronze tinted, transparent]** <Insert requirement>.
 7. Fall Protection Safety Structure: Manufacturer's standard meeting impact load requirements of 29 CFR 1910.23 and authorities having jurisdiction, **[equipped with hail protection galvanized steel wire mesh screen,]** and manually operable from exterior without special tools.
 8. Hardware: Manufacturer's standard, corrosion resistant; with hinges, hold-open devices, and independent manual-release devices for **[inside]** **[and]** **[outside]** operation of lids.

2.07 GRAVITY VENTILATORS

- A. Low-Profile, Cylindrical-Style Gravity Ventilators: Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.
 1. Construction: Integral base flange, vent cylinder, cylinder bird screen, and **[rain cap]** **[hood]**.
 2. Dimensions: **[As indicated on Drawings]** <Insert dimensions>.
 3. Configuration: **[As indicated on Drawings]** <Insert requirements>.
 4. Bird Screens: Manufacturer's standard mesh with rewirable frame.
 5. Insect Screens: Manufacturer's standard mesh with rewirable frame.
 6. Security Grille: **[Provide for all units]** **[Provide where indicated on Drawings]**.
 7. Vent Cylinder, Base Flange, Rain-Cap, and Hood Material: **[Zinc-coated (galvanized) steel]** **[Aluminum]** **[Stainless steel]** sheet, of manufacturer's standard thickness.
 8. Finish: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert finish>.

- B. Louvered Penthouse-Style Gravity Ventilators: Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.
1. Construction: Integral frame with base flange, weathertight cap [**with clear acrylic dome**] [**with white translucent acrylic dome**], and weatherproof sidewall louvers.
 2. Dimensions: [As indicated on Drawings] <Insert dimensions>.
 3. Configuration: [As indicated on Drawings] <Insert requirements>.
 4. Bird Screens: Manufacturer's standard mesh with rewireable frame.
 5. Insect Screens: Manufacturer's standard mesh with rewireable frame.
 6. Security Grille: [Provide for all units] [Provide where indicated on Drawings].
 7. Frame, Base Flange, Cap, and Louver Material: [Zinc-coated (galvanized) steel] [Aluminum] [Stainless steel] sheet, of manufacturer's standard thickness.
 8. Finish: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert finish>.
- C. Turbine-Style Gravity Ventilators: Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints:
1. Provide integral weathertight base cap, outlet duct, and rotating louvered turbine.
 2. Throat Size and Height: [As indicated on Drawings] <Insert dimensions>.
 3. Configuration: [As indicated on Drawings] <Insert requirements>.
 4. Bird Screens: Manufacturer's standard mesh with rewireable frame.
 5. Insect Screens: Manufacturer's standard mesh with rewireable frame.
 6. Security Grille: [Provide for all units] [Provide where indicated on Drawings].
 7. Weathertight Base Cap, Outlet Duct, and Turbine Material: [Manufacturer's standard] [Zinc-coated (galvanized) steel] [Aluminum] sheet, of manufacturer's standard thickness.
 8. Finish: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert finish>.

2.08 PIPE AND DUCT SUPPORTS

- A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to [1-1/2-inch] <Insert dimension> diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

- B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with **[polycarbonate]** **[stainless steel]** roller carrying assembly accommodating up to **[7-inch-]** **<Insert dimension>** diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to **[18 inch]** **<Insert dimension>** diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- D. Adjustable-Height Structure-Mounted Pipe Supports: Extruded-aluminum tube, filled with urethane insulation; **[2 inches]** **<Insert dimension>** in diameter; accommodating up to **[7-inch-]** **<Insert dimension>** diameter pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded-aluminum carrier assemblies; as required for quantity of pipe runs and sizes.
- E. Curb-Mounted Pipe Supports: Galvanized steel support with welded or mechanically fastened and sealed corner joints, **[straight sides,]** **[integral metal cant,]** **[stepped integral metal cant raised the thickness of roof insulation,]** and integrally formed deck-mounting flange at perimeter bottom; with adjustable-height roller-bearing pipe support accommodating up to **[20-inch-]** **<Insert dimension>** diameter pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.
- F. Duct Supports: Extruded-aluminum, urethane-insulated supports, **[2 inches]** **<Insert dimension>** in diameter; with manufacturer's recommended hardware for mounting to structure or structural roof deck.
 - 1. Finish: **[Manufacturer's standard]** **<Insert finish>**.

2.09 PIPE PORTALS

- A. Curb-Mounted Pipe Portal: Insulated roof-curb units with welded or mechanically fastened and sealed corner joints, **[straight sides,]** **[integral metal cant,]** **[stepped integral metal cant raised the thickness of roof insulation,]** and integrally formed deck-mounting flange at perimeter bottom; with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.
- B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.10 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, **[12 inches]** **<Insert dimension>** high, with removable metal hood and **[slotted]** **[perforated]** metal collar.
 - 1. Metal: Aluminum sheet, **[0.063 inch]** **<Insert thickness>** thick.

2. Diameter: [As indicated on Drawings] **[3 inches]** **[4 inches]** **[5 inches]** **[6 inches]** **[7 inches]** **[8 inches]** **[9 inches]** **[10 inches]** <Insert dimension>.
3. Finish: [Manufacturer's standard] <Insert finish>.

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Metal: [Aluminum sheet, **0.063 inch** thick] <Insert material and thickness>.
2. Height: **[7 inches]** **[13 inches]** **[19 inches]** <Insert dimension>.
3. Diameter: [As indicated on Drawings] **[2 inches]** **[3 inches]** **[4 inches]** **[5 inches]** **[6 inches]** <Insert dimension>.
4. Finish: [Manufacturer's standard] <Insert finish>.

2.11 ROOF WALKWAYS

A. Roof Walkway: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.

1. Include step units or stairs of similar construction for changes in elevation. Comply with ASCE-7, 29 CFR 1910.23, and requirements of authorities having jurisdiction.
2. Equip walkways with safety railings where required.
3. Plank Width: **[4-3/4 inches]** **[7 inches]** **[9-1/2 inches]** **[11-3/4 inches]** **[18-3/4 inches]** **[24 inches]** [As indicated].
4. Walkway Width: [As indicated] <Insert dimension>.
5. Channel Depth: **[1-1/2 inches]** **[2 inches]** **[2-1/2 inches]** **[3 inches]** [As indicated].
6. Metal Material: **[0.079-inch-** thick zinc-coated (galvanized) steel sheet] **[0.108-inch-** thick zinc-coated (galvanized) steel sheet] **[0.0625-inch-** thick stainless steel sheet] **[0.0781-inch-** thick stainless steel sheet] **[0.080-inch-** thick aluminum sheet] **[0.100-inch-** thick aluminum sheet] <Insert material and thickness>, perforated, with serrated slip-resistant walking surface.
7. Support Stands: Manufacturer's standard, with protective pads compatible with roofing material.
8. Support Pads: Continuous wood isolation pads, pressure-preservative treated as specified in Section 061000 "Rough Carpentry"; attach roof-walkway supports to pads so that supports are separated from roof membrane surface and walkway support loads are distributed evenly.
9. Wind Restraint: Provide wind restraint attachment to roof structure of size and spacing required to meet wind uplift requirements.
10. Finish: [Manufacturer's standard] <Insert finish>.

2.12 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation [**and mill phosphatized for field painting where indicated**].
1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
 3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 4. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
 5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
 2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- C. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Mill Finish: As manufactured.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.

3. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 4. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
 5. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 7. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- D. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.
- F. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- G. Steel Tube: ASTM A500/A500M, round tube.
- H. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- I. Steel Pipe: ASTM A53/A53M, galvanized.

2.13 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).
- C. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated according to UL 972 with an average impact strength of **[12 to 16 ft-lbf/in.]** <Insert value> of width when tested according to ASTM D256, Method A (Izod).
- D. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.
- E. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- F. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

- G. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, **[containing no arsenic or chromium,]** and complying with AWPA C2; not less than 1-1/2 inches thick.
- H. Security Grilles: **[3/4-inch]** <Insert dimension> diameter, ASTM A1011/A1011M steel bars spaced **[6 inches]** <Insert dimension> o.c. in one direction and **[12 inches]** <Insert dimension> o.c. in the other; factory finished as follows:
1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
 3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Underlayment:
1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D4397.
 3. Slip Sheet: Building paper, 3 lb/100 sq. ft. minimum, rosin sized.
 4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
- K. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- L. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- M. Elastomeric Sealant: ASTM C920, elastomeric **[polyurethane]** **[silicone]** polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

- N. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- O. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.14 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of **[uncoated aluminum]** **[stainless steel]** roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Attach ladder-assist post according to manufacturer's written instructions.
- F. Heat and Smoke Vent Installation:
1. Install heat and smoke vent so top perimeter surfaces are level.
 2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.
- G. Gravity Ventilator Installation: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.
- H. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- I. Preformed Flashing-Sleeve and Flashing-Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.
- J. Security Grilles: Weld bar intersections and **[, using tamper-resistant bolts, attach the]** ends of bars to structural frame or primary curb walls.
- K. Roof Walkway Installation:
1. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.
 2. Remove ballast from top surface of low-slope roofing at locations of contact with roof-walkway supports.
 3. Install roof walkway support pads prior to placement of roof walkway support stands onto low-slope roofing.

4. Redistribute removed ballast after installation of support pads.

L. Seal joints with **[elastomeric] [or] [butyl]** sealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 81 00
APPLIED FIRE PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sprayed fire-resistive materials.

B. Related Requirements:

1. Section 072100 "Thermal Insulation."
2. Section 078123 "Intumescent Fire Protection" for mastic and intumescent fire-resistive coatings.
3. Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding but not fire resistive.

1.02 DEFINITIONS

- A. SFRM: Sprayed fire-resistive materials.

1.03 PRE-INSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Sprayed fire-resistive materials.
2. Substrate primers.
3. Bonding agent.
4. Metal lath.
5. Reinforcing fabric.
6. Reinforcing mesh.
7. Sealer.
8. Topcoat.

- B. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.

3. Minimum sprayed fire-resistive material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
 4. Treatment of sprayed fire-resistive material after application.
- C. Samples: For each exposed product and for each color and texture specified, **[in manufacturer's standard dimensions] [4 inches square] <Insert dimensions>** in size.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer] [and] [testing agency]**.
- B. Product Certificates: For each type of sprayed fire-resistive material.
- C. Evaluation Reports: For sprayed fire-resistive material, from ICC-ES.
- D. Preconstruction Test Reports: For fire protection.
- E. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.
- B. Mockups: Build mockups **[to verify selections made under Sample submittals and to demonstrate aesthetic effects] [to set quality standards for materials and execution] [and] [for preconstruction testing]**.
 1. Build mockup of **[each type of fire protection and different substrate] [and] [each required finish]** <Insert description> as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: **[Owner will engage] [Engage]** a qualified testing agency to perform preconstruction testing on **[field mockups of]** fire protection.
 1. Field Mockup: <Insert sizes and configurations of assemblies>.
 2. Provide test specimens and assemblies representative of proposed materials and construction.
- B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
 1. Bond Strength: Test for cohesive and adhesive strength in accordance with ASTM E736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 2. Density: Test for density in accordance with ASTM E605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.

3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with sprayed fire-resistive material.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sprayed fire-resistive material manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.08 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is **[44 deg F]** <Insert temperature> or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of design: Isolatek International **[Other products are available]**.
 1. Other manufacturers are subject to compliance with requirements:
 - a. Grace Construction Products.
 - b. Carbolite Company; a subsidiary of RPM International.
 - c. Southwest Fireproofing Products Co.
 - d. E-Z Path cable wall penetrations.
- B. Basis of design: CAFCO Fendolite, Type M-II as manufactured by Isolatek International (High Density SFRMs).

2.02 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fire protection **[for each fire-resistance design]** from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested in accordance with **[ASTM E119 or UL 263]** <Insert requirement>; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Asbestos: Provide products containing no detectable asbestos.

2.03 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Sprayed Fire-Resistive Material: **<Insert drawing designation or UL-design number>** Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and **[mixed with water at Project site to form a slurry or mortar before conveyance and application] [or] [conveyed in a dry state and mixed with atomized water at place of application]**.
1. Application: Designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
 2. Bond Strength: Minimum **[150-lbf/sq. ft.] [430-lbf/sq. ft.] [1000-lbf/sq. ft.] <Insert value>** cohesive and adhesive strength based on field testing in accordance with ASTM E736.
 3. Density: Not less than density specified in the approved fire-resistance design, in accordance with ASTM E605.
 4. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375 inch.
 5. Combustion Characteristics: ASTM E136.
 6. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: **[10] <Insert number>** or less.
 - b. Smoke-Developed Index: **[10] <Insert number>** or less.
 7. Compressive Strength: Minimum **[10 lbf/sq. in.] [100 lbf/sq. in.] [300 lbf/sq. in.] <Insert value>** in accordance with ASTM E761.
 8. Corrosion Resistance: No evidence of corrosion in accordance with ASTM E937.
 9. Deflection: No cracking, spalling, or delamination in accordance with ASTM E759.
 10. Effect of Impact on Bonding: No cracking, spalling, or delamination in accordance with ASTM E760.
 11. Air Erosion: Maximum weight loss of **[0.025 g/sq. ft.] <Insert value>** in 24 hours in accordance with ASTM E859.
 12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in **[no growth on specimens per ASTM G21] [or] [rating of 10 in accordance with ASTM D3274 when tested in accordance with ASTM D3273]**.
 13. Sound Absorption: **[NRC] [or] [SAA] of [0.50 to 0.75] [0.60 to 0.70] [0.65 to 0.75] [not less than 0.60] <Insert range or single value>** in accordance with ASTM C423 for Type A mounting in accordance with ASTM E795.
 14. Finish: **[As selected by Architect from manufacturer's standard finishes] [Spray-textured finish] [Rolled, spray-textured finish] [Skip-troweled finish] [Skip-troweled finish with corner beads] <Insert requirement>**. **[Apply separate, colored topcoat after finishing.]**
 - a. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.

2.04 AUXILIARY MATERIALS

- A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

- B. Substrate Primers: Primers approved by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:
1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests in accordance with ASTM E736.
- C. Bonding Agent: Product approved by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, in accordance with fire-resistance designs indicated and sprayed fire-resistive material manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.
- G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.
- H. Topcoat: Suitable for application over sprayed fire-resistive material; of type recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.
1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.
 2. Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM. Provide application at a rate of **[30 sq. ft./gal.] [60 sq. ft./gal.] [120 sq. ft./gal.] <Insert value>**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.
1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.

2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- B. Verify that concrete work on steel deck is complete before beginning Work.
 - C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.
 - D. Conduct tests in accordance with sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
 - E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.
- B. Clean substrates of substances that could impair bond of fire protection.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION

- A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.
- B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
 1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- D. Metal Decks:

1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
 2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.
- E. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.
- F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.
- G. Extend fire protection in full thickness over entire area of each substrate to be protected.
- H. Install body of fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.
- I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.
- J. Where sealers are used, apply products that are tinted to differentiate them from fire protection over which they are applied.
- K. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.
- L. Cure fire protection in accordance with sprayed fire-resistive material manufacturer's written instructions.
- M. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.
- N. Finishes: Where indicated, apply fire protection to produce the following finishes:
1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
 2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
 3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
 4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
 5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: **[Owner will engage] [Engage]** a qualified special inspector to perform the following special inspections:
1. Test and inspect as required by the IBC [, Subsection 1705.13, "Sprayed Fire-Resistant Materials."] [, as indicated on Schedule of Special Inspections.] <Insert requirement.>

- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fire protection will be considered defective if it does not pass tests and inspections.
 - 1. Remove and replace fire protection that does not pass tests and inspections, and retest.
 - 2. Apply additional fire protection, in accordance with manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- D. Prepare test and inspection reports.

3.05 CLEANING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.06 PROTECTION

- A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.07 REPAIRS

- A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.
- B. Repair fire protection damaged by other work before concealing it with other construction.
- C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION

SECTION 07 81 23
INTUMESCENT FIRE PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Mastic and intumescent fire-resistive coatings.

B. Related Requirements:

1. Section 07 81 00 "Applied Fire Protection" for sprayed fire-resistive materials (SFRM).
2. Section 09 96 46 "Intumescent Painting" for intumescent paints that are fire retarding, but not fire resistive.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Mastic and intumescent fire-resistive coatings.
2. Substrate primers.
3. Reinforcing fabric.
4. Reinforcing mesh.
5. Topcoat.

B. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum mastic and intumescent fire-resistive coating thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of mastic and intumescent fire-resistive coating after application.

5. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 01 40 00 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.
- B. Qualification Data: For installer and testing agency.
- C. Product Certificates: For each type of mastic and intumescent fire-resistive coating.
- D. Evaluation Reports: For mastic and intumescent fire-resistive coating, from ICC-ES.
- E. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by mastic and intumescent fire-resistive coating manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.
- B. Mockups: Build mockups [to verify selections made under Sample submittals and to demonstrate aesthetic effects] [and] [to set quality standards for materials and execution].
 1. Build mockup of [each type of fire protection and different substrate] [and] [each required finish] <Insert description> as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is **[50 deg F]** <Insert temperature> or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements; provide products by one of the following:
 - 1. Isolatek International, CAFCO SprayFilm WB 4 System (basis of design).
 - 2. Albi Manufacturing; a division of StanChem, Inc.
 - 3. Carboline Company; a subsidiary of RPM International.

2.02 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fire protection **[for each fire-resistance design]** from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested in accordance with **[ASTM E119 or UL 263] <Insert requirement>**; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Asbestos: Provide products containing no detectable asbestos.

2.03 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

- A. Mastic and Intumescent Fire Resistive Coating, Interior Use:
 - 1. Factory mixed formulation consisting of intumescent base coat and topcoat (if required), and complying with indicated fire resistance design:
 - 2. Interior application: Designated for interior general purpose, conditioned interior space purpose use by a qualified testing agency acceptable to authorities having jurisdiction.
 - 3. Thickness: Required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
 - 4. Hardness: Not less than 65 Type D durometer, according to ASTM D2240.
 - 5. Finish is as selected by Architect from manufacturer's standard finishes or spray-textured finish:
 - 6. Color and gloss: As indicated by manufacturer's designations, match Architect's sample or as selected by Architect from manufacturer's full range.
- B. Mastic and Intumescent Fire Resistive Coating, Exterior Use:
 - 1. Factory mixed formulation consisting of intumescent base coat and topcoat (if required) and complying with indicated fire resistance design:
 - 2. Exterior application: Designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.

3. Thickness: Required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
4. Hardness: Not less than 65 Type D durometer, according to ASTM D2240.
5. Finish is as selected by Architect from manufacturer's standard finishes or spray-textured finish:
6. Color and gloss: As indicated by manufacturer's designations, match Architect's sample or as selected by Architect from manufacturer's full range.

2.04 AUXILIARY MATERIALS

- A. Provide auxiliary materials that are compatible with mastic and intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by mastic and intumescent fire-resistive coating manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer.
- D. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer. Include pins and attachment.
- E. Topcoat: Suitable for application over mastic and intumescent fire-resistive coating; of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer for each fire-resistance design.

PART 3 EXECUTION

3.01 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 50 degrees F (10 degrees C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

3.02

3.03 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
 2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- B. Conduct tests in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.
- B. Clean substrates of substances that could impair bond of fire protection.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by mastic and intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.05 APPLICATION

- A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fire protection Work.
- B. Comply with mastic and intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
 1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.

2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- D. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and mastic and intumescent fire-resistive coating manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer.
- E. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by mastic and intumescent fire-resistive coating manufacturer.
- F. Extend fire protection in full thickness over entire area of each substrate to be protected.
- G. Install body of fire protection in a single course unless otherwise recommended in writing by mastic and intumescent fire-resistive coating manufacturer.
- H. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.
- I. Cure fire protection in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions.
- J. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.
- K. Finishes: Where indicated, apply fire protection to produce the following finishes:
 1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
 2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
 3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

3.06 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections for tests and inspections as required by the CBC and DSA classified projects.
 1. Test and inspect as required by the IBC [, Subsection 17 05 .14, "Mastic and Intumescent Fire-Resistant Coatings."] [as indicated on Schedule of Special Inspections.] <Insert requirement.>
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fire protection will be considered defective if it does not pass tests and inspections.
 1. Remove and replace fire protection that does not pass tests and inspections, and retest.

2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.07 CLEANING, PROTECTING, AND REPAIRING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Protect fireproofing, according to advice of manufacturer and installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Substantial Completion.
- C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to Work of other trades.
- D. Repair fireproofing damaged by other work before concealing it with other construction.
- E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION

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SECTION 07 84 13
PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Penetration firestopping systems.
- B. Related Requirements:
 - 1. Section 07 84 43 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.02 ALLOWANCES

- A. Penetration firestopping Work is part of an allowance.

1.03 UNIT PRICES

- A. Work of this Section is affected by unit prices.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
 - 1. <Insert participants>.

1.05 ACTION SUBMITTALS

- A. Product Data: Penetration firestopping systems.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.07 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.010 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain penetration firestop systems for each type of opening indicated from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) FM Approvals in its "Approval Guide."

4) <Insert name of qualified testing and inspecting agency>.

2.03 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
 - 3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.

4. Steel sleeves.

2.04 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.
- K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.
- L. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814 or UL 1479 for membrane penetrations or ASTM E1725 or UL 1724 for thermal barrier and circuit integrity protection.
- M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.
- N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.
- O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

- P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.
- Q. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.
- R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch in diameter.
- S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.
- T. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.05 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION

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SECTION 07 84 43
JOINT FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Intumescent gypsum wall framing gaskets.
2. Perimeter fire-barrier system.
3. Joints in or between fire-resistance-rated construction.
4. Joints at exterior curtain-wall/floor intersections.
5. Joints in smoke barriers.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers **[and for wall identification]**.
2. Section 07 95 13.13 "Interior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
3. Section 07 95 13.16 "Exterior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
4. Section 07 95 13.19 "Parking Deck Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies subject to vehicular traffic.
5. Section 09 22 16 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.03 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

- B. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestop manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestop systems in EJs.

- C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an EJ or equivalent fire-resistance-rated assembly developed in accordance with current IFC guidelines.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.05 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems in accordance with manufacturer's written installation instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.08 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed in accordance with specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:

1. A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
2. Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) <Insert name of qualified testing agency>.
- B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.03 JOINT FIRESTOPPING SYSTEM TYPES

- A. General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
 1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
 2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
 3. Provide firestop products that do not contain ethylene glycol.
- B. Intumescent Gypsum Wall Framing Gaskets: Applied to steel tracks, runners, and studs prior to framing installation. Provide products with fire, smoke, and acoustical ratings that allow movement of up to 100 percent compression and/or extension when tested in accordance with UL 2079 or ASTM E1966; have an L Rating of less than 1 cfm/ft. when tested in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 when tested in accordance with ASTM E90 or ASTM C919.
- C. Perimeter Fire-Barrier System: Provide perimeter fire-barrier system that does not require direct screw attachment to mullions and transoms to support and fasten curtain-wall insulation for aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least 2-1/2 by 5 inches. System will be tested in accordance with ASTM E2307 for up to two-hour fire resistance and with ASTM E1233/E1233M for wind cycling equivalent to 108 mph wind for 500 cycles.
- D. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- E. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined in accordance with ASTM E2307.
1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- F. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined in accordance with UL 2079 based on testing at a positive pressure differential of 0.30 inch wg.
1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- G. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping systems, clean joints in accordance with fire-resistive joint system manufacturer's written installation instructions and the following requirements:
1. Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.

3.03 INSTALLATION

- A. General: Install joint firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
 - 1. Apply elastomeric fill in voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft..
- B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge, so labels are visible to anyone seeking to remove joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.07 JOINT FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product **[Category XHBN] [or] [Category XHDG]**.
- B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category **[Expansion/Seismic Joints] [or] [Firestop Systems]**.
- C. Floor-to-Floor, Joint Firestopping Systems: **<Insert drawing designation>**.
 - 1. UL-Classified Systems: FF- [D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 - 2. Assembly Rating: [One hour] [Two hours] <Insert number of hours>.
 - 3. Nominal Joint Width: [As indicated] <Insert dimension>.
 - 4. Movement Capabilities: [Class I] [Class II] [Class III] - <Insert number> percent [compression or extension] [compression, extension, or horizontal shear].
 - 5. L-Rating at Ambient: Less than **<Insert cfm/ft. >**.
 - 6. L-Rating at 400 Deg F (204 Deg C): Less than **<Insert cfm/ft. >**.
 - 7. W-Rating: No leakage of water at completion of water-leakage testing.
- D. Wall-to-Wall, Joint Firestopping Systems: **<Insert drawing designation>**.
 - 1. UL-Classified Systems: WW- [D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 - 2. Assembly Rating: [One hour] [Two hours] <Insert number of hours>.

3. Nominal Joint Width: [As indicated] <Insert dimension>.
 4. Movement Capabilities: [Class I] [Class II] [Class III] - <Insert number> percent [compression or extension].
 5. L-Rating at Ambient: Less than <Insert cfm/ft. >.
 6. L-Rating at 400 Deg F (204 Deg C): Less than <Insert cfm/ft. >.
- E. Floor-to-Wall, Joint Firestopping Systems: <Insert drawing designation>.
1. UL-Classified Systems: FW- [D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 2. Assembly Rating: [One hour] [Two hours] <Insert number of hours>.
 3. Nominal Joint Width: [As indicated] <Insert dimension>.
 4. Movement Capabilities: [Class I] [Class II] [Class III] - <Insert number> percent [compression or extension] [compression, extension, or horizontal shear].
 5. L-Rating at Ambient: Less than <Insert cfm/ft. >.
 6. L-Rating at 400 Deg F (204 Deg C): Less than <Insert cfm/ft. >.
- F. Head-of-Wall, Fire-Resistive Joint Firestopping Systems: <Insert drawing designation>.
1. UL-Classified Systems: HW- [D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 2. Intertek Group-Listed Systems: <Insert design number>.
 3. Assembly Rating: [One hour] [Two hours] <Insert number of hours>.
 4. Nominal Joint Width: [As indicated] <Insert dimension>.
 5. Movement Capabilities: [Class I] [Class II] [Class III] - <Insert number> percent [compression or extension].
 6. L-Rating at Ambient: Less than <Insert cfm/ft. >.
 7. L-Rating at 400 Deg F (204 Deg C): Less than <Insert cfm/ft. >.
- G. Bottom-of-Wall, Joint Firestopping Systems: <Insert drawing designation>.
1. UL-Classified Systems: BW- [D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 2. Assembly Rating: [One hour] [Two hours] <Insert number of hours>.
 3. Nominal Joint Width: [As indicated] <Insert dimension>.
 4. Movement Capabilities: [Class I] [Class II] [Class III] - <Insert number> percent [compression or extension].

5. L-Rating at Ambient: Less than **<Insert cfm/ft. >**.
 6. L-Rating at 400 Deg F (204 Deg C): Less than **<Insert cfm/ft. >**.
- H. Wall-to-Wall, Joint Firestopping Systems Intended for Use as Corner Guards: **<Insert drawing designation>**.
1. UL-Classified Systems: CG- **[D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999]**.
 2. Assembly Rating: **[One hour] [Two hours] <Insert number of hours>**.
 3. Nominal Joint Width: **[As indicated] <Insert dimension>**.
 4. Movement Capabilities: **[Class I] [Class II] [Class III] - <Insert number> percent [compression or extension]**.
 5. L-Rating at Ambient: Less than **<Insert cfm/ft. >**.
 6. L-Rating at 400 Deg F (204 Deg C): Less than **<Insert cfm/ft. >**.
- I. Perimeter Joint Firestopping Systems: **<Insert drawing designation>**.
1. UL-Classified Perimeter Fire-Containment Systems: CW- **[D] [S]-<Insert four-digit number> [0000-0999] [1000-1999] [2000-2999]**.
 2. Intertek Group-Listed, Perimeter Fire-Barrier Systems: **<Insert design number>**.
 3. Integrity Rating: **[One hour] [Two hours] <Insert number of hours>**.
 4. Insulation Rating: **[Zero hour] [1/4 hour] [3/4 hour] [1 hour] <Insert number of hours>**.
 5. Linear Opening Width: **[2-1/2 inches] [8 inches] [As indicated] <Insert dimension>**, maximum.
 6. Movement Capabilities: **[Class I] [Class II] [Class III] - <Insert number> percent [compression or extension]**.
 7. F-Rating: **[One hour] [Two hours] <Insert number of hours>**.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Related Requirements:

1. Section 07 91 00 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 07 92 19 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
3. Section 32 13 73 "Concrete Pavement Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.

9. Latex joint sealants.

- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.04 INFORMATIONAL SUBMITTALS

- A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.
- E. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Manufacturers' special warranties.
- B. Installer's special warranties.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.07 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with **[stone] [masonry] <Insert substrate>** substrates.
 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
 2. Conduct field tests for each kind of sealant and joint substrate.
 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.09 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer **[or are below 40 deg F]**.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: **[Two]** <Insert number> years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: **[Five]** <Insert number> years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer **[for each sealant type]**.

2.02 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

- B. Colors of Exposed Joint Sealants: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].**

2.03 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
- B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
- C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.
- D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.
- H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.
- I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.
- J. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

2.04 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

- C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
- D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

2.05 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.
- D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.
- E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
- F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.
- G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.
- H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.
- I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.
- J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

- K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

2.06 IMMERSIBLE JOINT SEALANTS

- A. Immersible Joint Sealants: Suitable for immersion in liquids; ASTM C1247, **[Class 1]** **[Class 2]**; tested in deionized water unless otherwise indicated.
- B. Urethane, Immersible, S, NS, 100/50, NT, I: Immersible, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses NT and I.
- C. Urethane, Immersible, S, NS, 35, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses NT and I.
- D. Urethane, Immersible, S, NS, 50, T, NT, I: Immersible, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T, NT, and I.
- E. Urethane, Immersible, S, NS, 35, T, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T, NT, and I.
- F. Urethane, Immersible, S, NS, 25, T, NT, I: Immersible, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T, NT, and I.
- G. Urethane, Immersible, S, P, 50, T, NT, I: Immersible, single-component, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 50, Uses T, NT, and I.
- H. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.
- I. Polysulfide, Immersible, M, NS, 25, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses NT and I.
- J. Urethane, Immersible, M, NS, 50, T, NT, I: Immersible, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T, NT, and I.
- K. Urethane, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.
- L. Polysulfide, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

- M. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, NT, and I.

2.07 SILANE-MODIFIED POLYMER JOINT SEALANTS

- A. Silane-Modified Polymer, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
- B. Silane-Modified Polymer, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.
- C. Silane-Modified Polymer, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- D. Silane-Modified Polymer, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 100, Uses T and NT.
- E. Silane-Modified Polymer, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.
- F. Silane-Modified Polymer, S, NS, 35, T, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T and NT.
- G. Silane-Modified Polymer, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.
- H. Silane-Modified Polymer, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

2.08 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

- C. Silane-Modified Polymer, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, **[silyl-terminated polyether] [silyl-terminated polyurethane] [polyurea]** joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.09 POLYSULFIDE JOINT SEALANTS

- A. Polysulfide, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Polysulfide, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.
- C. Polysulfide, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

2.10 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

2.11 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.12 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, **[Type C (closed-cell material with a surface skin)] [Type O (open-cell material)] [Type B (bicellular material with a surface skin)] [or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated]**, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.13 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - e. **<Insert other porous joint substrate>**.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
 - e. **<Insert other nonporous joint substrate>**.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide flush joint profile at **[locations indicated on Drawings]** <Insert locations> in accordance with Figure 8B in ASTM C1193.
 - 5. Provide recessed joint configuration of recess depth and at **[locations indicated on Drawings]** <Insert locations> in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - a. Extent of Testing: Test completed and cured sealant joints as follows:
 - 1) Perform **[10] <Insert number>** tests for the first **[1000 ft.] <Insert dimension>** of joint length for each kind of sealant and joint substrate.
 - 2) Perform one test for each **[1000 ft.] <Insert dimension>** of joint length thereafter or one test per each floor per elevation.
 - b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - c. Inspect tested joints and report on the following:
 - 1) Whether sealants filled joint cavities and are free of voids.
 - 2) Whether sealant dimensions and configurations comply with specified requirements.
 - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 - e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- C. Prepare test and inspection reports.

3.05 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

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SECTION 07 95 13

SEISMIC JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes prefabricated joint cover assemblies.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing:
 - 1. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.
- B. Pre-installation meeting:
 - 1. Convene minimum two weeks prior to starting work of this section.

1.03 SUBMITTALS

- A. Data: Manufacturer Product Data for each type and profile of assembly, including material list, finish, and test results for fire-rated assemblies.
- B. Shop drawings: Supplement data with Shop Drawings showing the following.
 - 1. Joint system schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - a. Manufacturer and model number for each joint system.
 - b. Joint system location cross-referenced to Drawings.
 - c. Loads used in design of the floor joint systems.
 - d. Nominal joint width.
 - e. Movement capability.
 - f. Classification as thermal or seismic.
 - g. Materials, colors, and finishes.
 - h. Materials, colors, and finishes.
 - i. Product options.
 - j. Fire-resistance ratings.
- C. Layout Drawings:
 - 1. Placement drawings showing line diagrams for the entire route of each joint system, in plan, elevation, and section, full size details, splices, blockout requirement, and attachments to other work.
 - 2. Where joint systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
 - 3. Show and identify fasteners and anchors to be embedded in concrete, dimensioned location, setting-out dimensions and acceptable setting tolerances.

4. Details of each type of embedded anchor required for the work of this Section.
5. Identify areas of the building to which the work of this Section is attached with embedded anchorage, as well as areas of the building to which the work of this Section will be attached without the use of embedded anchorage.

D. Samples:

1. For each joint, complete assembly of each type. Include prototype units for custom fabrication.
2. Each color and finish selected. Include custom colors.
3. Representative transition and corner fitting fabrications to confirm quality of work as a standard for work on the Project.

E. Certificates: Certificates, research report number, or other proof that assemblies used in fire-rated construction are approved by the authorities having jurisdiction for the conditions of use.

1.04 QUALITY ASSURANCE

A. Requirements of regulatory agencies:

1. Comply with fire resistance ratings indicated and required by Code.
2. Provide materials, accessories and application procedures which have been tested by a testing agency acceptable to authorities having jurisdiction.

B. Single source responsibility: Provide all components for each assembly from one manufacturer.

1.05 HANDLING

A. Wrap joint assemblies individually, and provide strippable protection on metal surfaces to avoid damage during handling and installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following, or equal:

1. Specialties Building Components, Inc.
2. Balco, a CSW Industrial Company.
3. Construction Specialties, Inc. (CS Group).
4. MM Systems.
5. Or equal.

2.02 PERFORMANCE REQUIREMENTS:

A. Joint assemblies shall permit unrestrained movement of joint without disengagement of and, where applicable, remain watertight and maintain the fire-rated protection of the adjacent assemblies.

B. Provisions for movement of the structure:

1. The building is in the Seismic Design Category (SDC) indicated, as defined by the CBC. Install joint assemblies requiring special bracing or mounting to meet seismic movements for the SDC indicated.

2. This work shall be engineered, detailed, and installed to accommodate dead load and live load deflection, thermal expansion, creep, sway, drift, and torsion of the structure as may be anticipated by seismic and other conditions. Live loads used in design shall be the same as adjacent floor with the highest live load.
3. Identify on the Shop Drawings the amount of movement that is accommodated in the engineering and details.

2.03 MATERIALS

- A. Aluminum: ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 6061-T6, sheet and plate. Apply protective coating on aluminum surfaces in contact with cementitious materials.
- B. Stainless steel: ASTM A 167 and A 480, non-magnetic, 300 series.
- C. Non-metallic products:
 1. Extruded preformed seals: Single- or multi-layered rubber extrusions as classified under ASTM D 2000, designed with or without continuous, longitudinal, internal baffles and formed to fit compatible frames, in color indicated, or, if not indicated, as selected by Architect from manufacturer's standard colors.
 2. Elastomeric sealant: Manufacturer's standard elastomeric sealant complying with ASTM C 920, Use T, factory-formed and bonded to metal frames or anchor members; in color selected by Architect from manufacturer's palette.
 3. Seismic seals: Typically 2 single layered rubber extrusions, one interior and one exterior, as classified under ASTM D 2000, retained in a set of compatible frames, in color indicated selected by Architect from manufacturer's palette.
 4. Water barrier sheets: Neoprene or EPDM flexible sheet materials minimum 45 mils thick.
 5. Nonmetallic, Shrinkage Resistant Grout: ASTM C1107/C1107M, factory packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
 6. Fire barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue. Tested in maximum joint width condition with a field splice as a component of an expansion joint in compliance with UL 263, NFPA 251, UBC 43-1, or ASTM E 119 and E 814 including hose stream test at full-rated period by a nationally recognized testing and inspecting organization or by other means acceptable to authorities having jurisdiction.
- D. Protective coatings:
 1. Bituminous paint: FS TT-C-494.
 2. Zinc-dust primer: FS TT-P-460.
 3. Galvanized repair paint: "94-H20 Hydro-Zinc" by Tnemec Co., or equal
- E. Fastening devices:
 1. General: Provide recommended attachment devices required to suit each loading condition. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations. If not otherwise indicated, fasteners and anchors shall be non-magnetic stainless steel, Series 300.
 2. Threaded fasteners:
 - a. Metal-to-metal: Machine bolts and nuts, self-tapping screws, and other as engineered by unit manufacturer to suit condition.

- b. Metal-to-concrete: Expansion bolts, drilled-in type.
 - c. For stainless steel and aluminum: Stainless steel, ANSI Type 304 at exterior conditions; aluminum or stainless steel at interior conditions.
 - d. For steel: Low carbon steel, ASTM A 307, hot-dip galvanized for exterior use and where galvanized assemblies are indicated.
- F. Accessories: Manufacturer's standard spacers, flexible vapor seals and filler materials, drain tubes, adhesive, and other accessories compatible with material in contact.

2.04 FABRICATION

- A. Provide joint assemblies of design, basic profile, materials, and operation indicated.
- B. Furnish units in longest practicable lengths to minimize number of joints. Provide hairline mitered corners where joint changes directions or abuts other materials.
- C. Include closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories required to provide continuous joint assemblies.
- D. Fabricate special transitions and closures, corner fittings and the like as required to minimize field joints. Miter and weld joints as applicable to condition. Provide monolithic elastomeric seal and sealed butt joints where indicated and to form watertight or airtight seals.
- E. Shop prime/protective coat metals to be in contact with cementitious materials for corrosion resistance. Use aluminum primer (alkyd barium metaborate) on aluminum.

2.05 FINISHING

- A. Aluminum: Finish exposed surfaces with a clear anodized finish complying with AA-C22A41; medium matte etched finish with 0.7 mil minimum thick anodic coating.
- B. Stainless steel:
 - 1. Bright, directional polish: NAAMM No. 4 finish.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.02 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.
- C. Furnish units in longest practicable lengths to minimize field splicing.
- D. Include factory fabricated closure materials and transition pieces, T joints, corners, curbs, cross connections, and other accessories as required to provide continuous expansion joint cover assemblies.

3.03 INSTALLATION

A. General:

- 1. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- 2. Comply with the joint assembly manufacturer's instructions and the tested procedure for fire-rated assemblies.
- 3. Install assemblies over the prepared opening, plumb, level and square, with hairline, flush joints.
- 4. Provide concealed back-up plates at sliding joints to avoid exposed fasteners, whenever possible. Attach assemblies securely to supports. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- 5. Protect aluminum surfaces in contact with cementitious materials as specified above.
- 6. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- 7. Terminate exposed ends of expansion joint cover assemblies with field or factory fabricated termination devices.
- 8. Fire Resistance Rated Assemblies:
 - a. Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements:
 - 1) Fire barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
- 9. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

B. Cutting, fitting and placement:

- 1. Perform cutting, drilling, and fitting required for installation of joint assemblies.
- 2. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling.
- 3. Set floor covers flush with adjacent finished floor materials.
- 4. Locate wall and ceiling covers flush with, and in continuous contact with adjacent surfaces.

C. Joinery and continuity:

- 1. Maintain continuity of joint assemblies with end joints held to a minimum and metal members aligned mechanically using splice joints.

2. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal without buckling of frames.
3. Adhere flexible filler materials to frames as recommended by manufacturer.

D. Extruded preformed seals:

1. Install with minimum number of end joints. For straight sections provide preformed seals in continuous lengths. Vulcanize or heat-seal field splice joints to provide watertight joints using manufacturer's recommended procedures. Seal transitions in compliance with manufacturer's instructions.
2. Where joints change direction and must be weathertight, vulcanize or chemically-bond flexible components; seal metal components with compatible sealants finished flush with adjacent surfaces.

- E. Remove protective covers and touchup damaged finishes when the results are satisfactory to the Architect, otherwise replace damaged components.

3.04 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION

DIVISION 08

OPENINGS

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.

B. Related Requirements:

1. Section 081119 "Stainless-Steel Doors and Frames" for hollow-metal doors and frames manufactured from stainless steel.
2. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
3. Section 119812 "Detention Doors and Frames" for hollow-metal doors and frames for detention facilities.
4. Section 134900 "Radiation Protection" for lead-lined, hollow-metal doors and frames.

1.02 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.03 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.05 ACTION SUBMITTALS

A. Product Data:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, core descriptions, **[fire-resistance ratings,] [temperature-rise ratings,]** and finishes.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

D. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.

E. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
2. Fabrication: Prepare Samples approximately **[12 by 12 inches] [8 by 10 inches]** **<Insert dimension>** to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

F. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.

2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

- B. Product Test Reports: For each type of [fire-rated hollow-metal door and frame assembly] [fire-rated borrowed-lite assembly] [windborne-debris impact resistance door] [and] [thermally rated door assemblies] for tests performed by a qualified testing agency indicating compliance with performance requirements.
- C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.
- D. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.08 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings **[and temperature-rise limits]** indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 3. Temperature-Rise Limit: **[Where indicated on Drawings] [At vertical exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.
- C. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone **[1] [2] [3] [4]** for **[basic] [enhanced]** protection.
1. Large-Missile Test: For glazed openings located within **[30 feet]** <Insert dimension> of grade.
- D. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than **[0.50 deg Btu/F x h x sq. ft.] [0.40 deg Btu/F x h x sq. ft.] [0.38 deg Btu/F x h x sq. ft.]** <Insert U-factor> when tested in accordance with ASTM C1363 or ASTM E1423.

2.02 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Standard-Duty Doors and Frames: ANSI/SDI A250.8, Level 1; ANSI/SDI A250.4, Level C. **[At locations indicated in the Door and Frame Schedule on Drawings]** <Insert locations>.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule on Drawings.

- b. Thickness: **[1-3/4 inches]** **[1-3/8 inches]**.
 - c. Face: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of 0.032 inch.
 - d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Core: [Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - g. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
2. Frames:
- a. Materials: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of 0.042 inch.
 - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].
3. Exposed Finish: **[Prime]** **[Factory]**.
- C. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
1. Doors:
- a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Core: [Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - g. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
2. Frames:
- a. Materials: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of 0.053 inch.

- b. Sidelites and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].
3. Exposed Finish: **[Prime] [Factory]**.
- D. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
1. Doors:
- a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.053 inch.
 - d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless] [Model 3, Stile and Rail].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Core: [Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - g. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
2. Frames:
- a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.053 inch.
 - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].
3. Exposed Finish: **[Prime] [Factory]**.
- E. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
1. Doors:
- a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.067 inch.

- d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Core: [Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - g. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
2. Frames:
- a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.067 inch.
 - b. Sidelites and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].
3. Exposed Finish: **[Prime] [Factory]**.

2.03 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.

1. Doors:
- a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum **[A40] [A60]** coating.
 - d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors **[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

- h. Core: [Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - i. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.
 - 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum **[A40] [A60]** coating.
 - b. Construction: [Knocked down] [Face welded] [Full profile welded].
 - 3. Exposed Finish: **[Prime] [Factory]**.
- C. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
- 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum **[A40] [A60]** coating.
 - d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless] [Model 3, Stile and Rail].
 - e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors **[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: [Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
 - i. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.
 - 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum **[A40] [A60]** coating.
 - b. Construction: [Knocked down] [Face welded] [Full profile welded].

3. Exposed Finish: **[Prime] [Factory]**.

D. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule on Drawings.
- b. Thickness: 1-3/4 inches.
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum **[A40] [A60]** coating.
- d. Edge Construction: [Model 1, Full Flush] [Model 2, Seamless].
- e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**] [Provide manufacturer's standard beveled or square edges].
- f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- g. Bottom Edges: Close bottom edges of doors **[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- h. Core: [Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener].
- i. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.

2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum **[A40] [A60]** coating.
- b. Construction: [Knocked down] [Face welded] [Full profile welded].

3. Exposed Finish: **[Prime] [Factory]**.

2.04 INTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Hollow-Metal Doors and Frames: NAAMM-HMMA 860; ANSI/SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule on Drawings.
- b. Thickness: 1-3/4 inches.

- c. Face: [Uncoated] [Metallic-coated] steel sheet, minimum thickness of **[0.032 inch] [0.042 inch] [0.053 inch]**.
 - d. Edge Construction: [Continuously welded with no] [Projection or tack welded with no] [Interlocking with] [Projection or tack welded with] visible seam.
 - e. Core: Steel stiffened.
 - f. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
2. Frames:
- a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.053 inch.
 - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].
3. Exposed Finish: Prime.
- B. Commercial Doors and Frames: NAAMM-HMMA 861; ANSI/SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: Continuously welded with no visible seam.
 - e. Core: Steel stiffened.
 - f. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.
 2. Frames:
 - a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.053 inch, except 0.067 inch for openings exceeding 4 feet wide.
 - b. Sidelite and Transom Frames: Fabricated from same material as adjacent door frame.
 - c. Construction: **[Face] [Full profile]** welded.
 3. Exposed Finish: Prime.

C. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; ANSI/SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule on Drawings.
- b. Thickness: 1-3/4 inches.
- c. Face: [Uncoated] [Metallic-coated] steel sheet, minimum thickness of **[0.032 inch] [0.042 inch] [0.053 inch]**.
- d. Edge Construction: [Continuously welded with no visible seam] [Interlocking with visible seam] [Interlocking with no visible seam] [Projection, spot, or tack welded with or without visible seams].
- e. Edge Bevel: [Bevel lock and hinge edges **1/8 inch in 2 inches**] [Bevel lock edge **1/8 inch in 2 inches**].
- f. Core: [Kraft-paper honeycomb] [Polyisocyanurate] [Polystyrene] [Polyurethane] [Vertical steel stiffener].
- g. Fire-Rated Core: Manufacturer's standard [vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated] doors.

2. Frames:

- a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.053 inch.
- b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
- c. Construction: [Knocked down] [Slip-on drywall] [Face welded] [Full profile welded].

3. Exposed Finish: [Prime] [Unprimed].

2.05 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Commercial Doors and Frames: NAAMM-HMMA 861; ANSI/SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule on Drawings.
- b. Thickness: 1-3/4 inches.
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G60 or A60 coating.
- d. Edge Construction: Continuously welded with no visible seam.

- e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - f. Bottom Edges: Close bottom edges of doors [**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - g. Core: Steel stiffened.
2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, except 0.067 inch for openings exceeding 4 feet wide; with minimum G60 or A60 coating.
 - b. Construction: **[Face] [Full profile]** welded.
 3. Exposed Finish: Prime.
- B. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; ANSI/SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule on Drawings] <Insert locations>**.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of **[0.053 inch] [0.042 inch]**, with minimum G60 or A60 coating.
 - d. Edge Construction: [Continuously welded with no visible seam] [Interlocking with visible seam] [Interlocking with no visible seam] [Projection, spot, or tack welded with or without visible seams].
 - e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - f. Bottom Edges: Close bottom edges of doors [**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - g. Core: [Kraft-paper honeycomb] [Polyisocyanurate] [Polystyrene] [Polyurethane] [Vertical steel stiffener].
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G60 or A60 coating.
 - b. Construction: [Knocked down] [Face welded] [Full profile welded].

3. Exposed Finish: [Prime] [Unprimed].

2.06 BORROWED LITES

- A. Fabricate of [uncoated] [metallic-coated] steel sheet, minimum thickness of **[0.053 inch]** **[0.042 inch]**.
- B. Construction: **[Knocked down]** **[Face welded]** **[Full profile welded]**.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.07 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.08 FRAME ANCHORS

- A. Jamb Anchors:
 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.09 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.10 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding **[, or by rigid mechanical anchors]**.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 - 4. Terminated Stops (Hospital Stops): Terminate stops **[6 inches]** <Insert dimension> above finish floor with a **[45] [90]**-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with **[butted] [or] [mitered]** hairline joints.

1. Provide stops and moldings flush with face of door, and with **[beveled] [square]** stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.11 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
- B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

2.12 LOUVERS

- A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.
1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
 2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
 3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

PART 3 EXECUTION

3.01 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with [ANSI/SDI A250.11] [NAAMM-HMMA 840].
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
 - 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 4. Solidly pack mineral-fiber insulation inside frames.
 - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. **[Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.]**
 - 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with [ANSI/SDI A250.8] [NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated].
 2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
 3. Smoke-Control Doors: Install doors in accordance with NFPA 105.
- D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in **[NFPA 80] [and] [NFPA 101]**.

3.04 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish in accordance with manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

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SECTION 08 11 16

INTERIOR ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pre-finished aluminum door frames for interior use.
 - 2. Pre-finished aluminum window frames for interior use.
 - 3. Pre-finished aluminum framing system for interior use.
 - 4. Pre-finished aluminum doors for interior use.
- B. Related Requirements: Section 08 11 13 Hollow Metal Doors and Frames.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing
- B. Pre-installation meeting

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Templates: Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the interior aluminum door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
 - 1. Frame details for each frame type, including dimensioned profiles.
 - 2. Locations of reinforcement and preparations for hardware.
 - 3. Details of each different wall opening condition. Include requirements for steel framing at partitions for fit and securing of frames, partition widths and tolerances, direction of framing members, clips and attachments.
 - 4. Details of anchorages, joints, field splices, and connections.
 - 5. Details of accessories.
 - 6. Details of moldings, removable stops, and glazing.
 - 7. Elevations of each door design.
 - 8. Details of doors, including vertical and horizontal edge details.
 - 9. Details of preparations for power, signal, and control systems.
- D. Samples for verification: Provide, at the request of architect, prepared Samples as indicated below:

1. Framing Member: 12 inches long
 2. Corner Fabrication: 12-by-12-inch-long, full size window corner, including full-size sections of extrusions with factory-applied finish.
 3. Aluminum chips in full range of manufacturer's standard finishes for architect's color selection.
- E. Interior Aluminum Door and Frame Schedule: Use same designations indicated on Drawings. Coordinate with Door Hardware schedule and glazing.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain aluminum frames and doors through one source from a single qualified manufacturer.
- B. Manufacturer Qualifications: A firm experienced in the manufacturing of interior aluminum framing systems and doors with a minimum five (5) years successful in-service performance providing product similar to those indicated, including pre-engineering and pre-fabricating all components of aluminum framing systems and doors.
- C. Installer Qualifications: An experienced installer with a minimum five (5) years experience who has completed aluminum framing systems and door installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
- D. Aesthetic Effects: Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. Fire Rated Assemblies: In locations where fire-rated openings are scheduled or required by regulatory agencies, provide fire-rated aluminum frames that have been tested and certified for specified exposure by an agency acceptable to governing authorities.
1. Provide labels permanently fastened on each frame that is within size limits established by NFPA and the testing authority.
 - a. Provide 20-minute labels.
 - b. Provide 90-minute labels.
 - c. Provide labels for openings as scheduled on the drawings.
- F. Pre-Installation Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing interior aluminum frames and doors and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver interior aluminum frames and doors individually protective wrapped within cartons and marked for the corresponding scheduled opening. Do not bulk pack frames.
- B. Inspect frames upon delivery for damage.
1. Repair minor damage to pre-finished products as recommended by Manufacturer.
 2. Replace frames that cannot be satisfactorily repaired.

- C. Store Interior aluminum frames and doors at Project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of interior aluminum frame openings by field measurements before fabrication and indicate measurements on Shop Drawings submittals.
- B. Do not begin installation of aluminum frames and doors until area of work has been completely enclosed and interior is protected from the elements.
- C. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy standards. If necessary, provide artificial heating, cooling, and ventilation to maintain required environmental conditions.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Aluminum knock-down frames shall be used for interior doors to private offices, closets, conference rooms, break rooms, private toilets and other infrequent use doors.
- B. Provide door assemblies that have been designed and fabricated in compliance with specified performance requirements.
- C. Conform to applicable Building Code for fire rated assemblies.
- D. Fire rated assembly construction to conform to UL 10C.
- E. Installed Frame and Door Assemblies: Comply with NFPA 80 for fire rated class indicated.
- F. Installed Fire-rated Window Assemblies: Comply with NFPA 257 for fire rated class indicated.
- G. Installed Smoke Control Frame and Door Assemblies: Comply with NFPA 105.

2.02 GENERAL

- A. Locations: Private offices, closets, conference rooms, break rooms, private toilets and other infrequent use doors
- B. Accessibility: Comply with ICC A117.1 and ADA Standards.

2.03 DOORS

- A. Flush Aluminum Doors with Aluminum Face Sheets: Aluminum internal framing and faces; no steel components.
 - 1. Thickness: 1-3/4-inches.

2.04 FRAMES

- A. Locations: Private offices, closets, conference rooms, break rooms, private toilets and other infrequent use doors

- B. Door Frames: Extruded aluminum hollow or C-shaped sections; no steel components.
 - 1. Frame Depth: To fit wall thicknesses as indicated on drawings.
 - 2. Frames for Fire-Rated Doors Specified Elsewhere: Tested in accordance with NFPA 252, listed and labeled by UL (DIR), ITS (DIR), or testing agency acceptable to authorities having jurisdiction.
- C. Dimensions and Shapes: As indicated on drawings; dimensions indicated are nominal.
 - 1. Provide the following clearances:
 - a. Hinge and Lock Stiles: 1/8 inch.
 - b. Between Meeting Stiles: 1/4 inch.
 - c. At Top Rail and Bottom Rail: 1/8 inch.

2.05 MATERIALS

- A. Aluminum Materials - General: Comply with recycled content product requirements specified in Section 01 81 13 - Sustainable Design Requirements.
- B. Recycled Content of Aluminum Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.
- C. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy 5005-H14, stretcher leveled.
- D. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063-T5 or alloy 6463-T5.

2.06 FABRICATION-DOORS

- A. Factory pre-engineer aluminum doors and components to the greatest extent practical.
- B. Hardware Preparations: Factory interior aluminum doors to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tap ping according to the Door Hardware Schedule and templates as specified in Section 08 71 00 Door Hardware:
 - 1. Reinforce doors to receive surface mounted door hardware. Machine and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within door with concealed screws.
 - 2. Locate hardware as indicated.
 - 3. Coordinate locations of conduit and power transfers for electrical connections with Division 26 Sections.
- C. Clearances for Non-Fire-Rated Door Frames: Not more than 1/8" at jambs and heads, not more than 1/4-inch between pairs of doors. Not more than 3/4-inch at bottom.
- D. Fabricate kits for glazing with removable stops to allow glazing replacement without dismantling.

2.07 FABRICATION-FRAMES

- A. Shop fabricate and finish the frames with rigid connections and hairline, flush fit at corners.
- B. Provide concealed corner reinforcements and alignment clips for precise joints at butt or mitered connections.
- C. Fabricate all components to allow secure installation without exposed fasteners.

- D. Reinforce frames to receive finish hardware specified in Section 08 71 00. Provide closer reinforcement in the head of all frames.

2.08 FINISHES

- A. Class I Clear Anodized Finish: Clear anodic coating; AAMA 611 AA-M12C22A41, minimum dry film thickness (DFT) of 0.7 mils, 0.0007 inch.
- B. Class I Color Anodized Finish: Electrolytically deposited colored anodic coating; AAMA 611 AA-M12C22A44, minimum dry film thickness (DFT) of 0.7 mils, 0.0007 inch.
- C. Superior Performing Organic Coatings System: Manufacturer's standard multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent polyvinylidene fluoride (PVDF) resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings.
 - 1. At fire-protection-rated openings, install frames according to NFPA 80.
- B. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.
- C. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.
- D. Install door hardware as specified in Section 08 71 00 - Door Hardware.
- E. Do not use screws or other fasteners exposed to view when installation is complete.
- F. Install glazing; set glazing stops and glazing gaskets flush with face of door or frame.
- G. Comply with glazing installation requirements of Section 08 80 00 - Glazing.

3.03 INSTALLATION TOLERANCES

- A. Adjust frames for squareness, alignment, twist, and plumb to the following tolerances:

- B. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
- C. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.
- D. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
- E. Plumbness: Plus or minus 1/16-inch, measured at jambs at floor.

3.04 ADJUSTING

- A. Inspect installation, correct misalignments, and tighten loose connections.
- B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.
- C. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepaired surface so touchup is not visible from a distance of 48 inches (1220 mm) as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Solid-core five-ply flush wood veneer-faced doors and transom panels for transparent finish.
2. Solid-core five-ply flush wood doors and transom panels for opaque finish.
3. **[Solid-core seven-ply flush wood veneer-faced doors and transom panels for transparent finish.]**
4. **[Solid-core seven-ply flush wood doors and transom panels for opaque finish.]**
5. Fire-rated wood door frames.
6. Light frames and louvers.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Solid-core five-ply flush wood veneer-faced doors and transom panels for transparent finish.
2. Solid-core five-ply flush wood doors and transom panels for opaque finish.
3. **[Solid-core seven-ply flush wood veneer-faced doors and transom panels for transparent finish.]**
4. **[Solid-core seven-ply flush wood doors and transom panels for opaque finish.]**
5. Solid-core flush wood doors and transom panels with plastic-laminate-faces.
6. Hollow-core flush wood veneer-faced doors for transparent finish.
7. Hollow-core flush wood doors for opaque finish.
8. Hollow-core flush wood doors with plastic-laminate faces.
9. Fire-rated wood door frames.
10. Light frames and louvers.

B. Product Data Submittals: For each product, including the following:

1. Door core materials and construction.
2. Door edge construction

3. Door face type and characteristics.
 4. Door louvers.
 5. Door trim for openings.
 6. Door frame construction.
 7. Factory-machining criteria.
 8. Factory-**[priming]** **[finishing]** specifications.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
1. Door schedule indicating door **[and frame]** location, type, size, fire protection rating, and swing.
 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
 3. Details of frame for each frame type, including dimensions and profile.
 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 5. Dimensions and locations of blocking for hardware attachment.
 6. Dimensions and locations of mortises and holes for hardware.
 7. Clearances and undercuts.
 8. Requirements for veneer matching.
 9. Doors to be factory **[primed]** **[finished]** and application requirements.
 10. Apply **[NAAWS Quality Certification]** **[NAAWS Certified Compliance]** **[AWI Quality Certification]** **[WI Certified Compliance]** Program label to Shop Drawings.
- D. Samples for Initial Selection: For **[plastic-laminate door faces]** **[polymer edging]** **[factory-finished doors]** **[and]** **[factory-finished door frames]**.
- E. Samples for Verification:
1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. **[For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.]**
 2. Plastic laminate, 6 inches square, for each color, texture, and pattern selected.
 3. Polymer edging, in manufacturer's standard colors.
 4. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
 5. Louver blade and frame sections, 6 inches long, for each material and finish specified.
 6. Frames for light openings, 6 inches long, for each material, type, and finish required.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
 3. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.
- 1.05 CLOSEOUT SUBMITTALS
- A. Special warranties.
- B. Quality Standard Compliance Certificates: **[NAAWS Quality Certification] [NAAWS Certified Compliance] [AWI Quality Certification] [WI Certified Compliance]** Program certificates.
- C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.
- 1.06 QUALITY ASSURANCE
- A. Manufacturer's Certification: Licensed participant in **[NAAWS Quality Certification] [NAAWS Certified Compliance] [AWI's Quality Certification Program] [WI's Certified Compliance Program]**.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in **[plastic bags or cardboard cartons] [cardboard cartons, and wrap bundles of doors in plastic sheeting]**.
- C. Mark each door on **[top and]** bottom rail with opening number used on Shop Drawings.
- 1.08 FIELD CONDITIONS
- A. Environmental Limitations:

1. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
2. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between **[25 and 55] [43 and 70] [17 and 50] <Insert numbers>** percent during remainder of construction period.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors **[and frames]** that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors **[and frames]**.
 3. Warranty Period for Solid-Core Exterior Doors: **[Two] [Five] <Insert number>** years from date of Substantial Completion.
 4. Warranty Period for Solid-Core Interior Doors: Life of installation.
 5. Warranty Period for Hollow-Core Interior Doors: **[One] [Two] <Insert number>** year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain flush wood doors **[indicated to be blueprint matched with paneling] [and wood paneling]** from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings **[and temperature-rise limits] indicated** on Drawings, based on testing at positive pressure in accordance with **[UL 10C] [or] [NFPA 252]**.
1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

2. Temperature-Rise Limit: **[Where indicated on Drawings] [At vertical exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

- B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.03 FLUSH WOOD DOORS AND FRAMES, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with **[AWI/AWMAC/WI's "Architectural Woodwork Standards."]** **[ANSI/WDMA I.S. 1A.]**

1. Provide **[labels] [and] [certificates]** from **[NAAWS] [AWI] [WI]** certification program indicating that doors **[and frames]** comply with requirements of grades specified.
 - a. This project has been registered with AWI as AWI Quality Certification Program Number **<Insert number>**.
 - b. Contractor registers the Work under this Section with the **[NAAWS Quality Certification Program at www.NAAWS.com or by calling 916-372-9943.] [AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.]**
2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.04 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS FOR TRANSPARENT FINISH

- A. Exterior Doors, Solid-Core Five-Ply Veneer-Faced **<Insert drawing designation>**:

1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [as indicated on Drawings]**.
2. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
3. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
4. Faces: Single-ply wood veneer not less than 1/50 inch thick.
 - a. Species: **[Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>**.
 - b. Cut: **[Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut]**.
 - c. Match between Veneer Leaves: **[Book] [Slip] [Random]** match.
 - d. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
 - e. Pair and Set Match: Provide for doors hung in same opening **[or separated only by mullions]**.

5. Exposed Vertical and Top Edges: **[Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A] [Same species as faces - Architectural Woodwork Standards edge Type A] [Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B] [Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D].**
 6. Core:
 - a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lb]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lb]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
 7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
 8. Adhesives: Type I in accordance with WDMA T.M. 6.
- B. Interior Doors, Solid-Core Five-Ply Veneer-Faced **<Insert drawing designation>**:
1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [Standard Duty] [as indicated on Drawings]**.
 2. Performance Grade by Location:
 - a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [Classrooms] [public toilets] [janitor's closets] [assembly spaces] [exits] [and] [patient rooms] **<Insert locations>** [and where indicated on Drawings].
 - b. ANSI/WDMA I.S. 1A Standard Duty: [Closets (not including janitor's closets)] [and] [private toilets] **<Insert locations>** [and where indicated on Drawings].
 3. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 4. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 5. Faces: Single-ply wood veneer not less than 1/50 inch thick.
 - a. Species: [Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] **<Insert species>**.
 - b. Cut: [Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut].
 - c. Match between Veneer Leaves: **[Book] [Slip] [Random]** match.

- d. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
 - e. Pair and Set Match: Provide for doors hung in same opening **[or separated only by mullions]**.
 - f. Room Match:
 - 1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by **[10 feet] [20 feet] <Insert dimension>** or more.
 - 2) Provide door faces of compatible color and grain within each separate room or area of building.
 - g. Transom Match: **[Continuous match] [End match] [As indicated]**.
 - h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 06 42 16 "Flush Wood Paneling."
6. Exposed Vertical and Top Edges: **[Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A] [Same species as faces - Architectural Woodwork Standards edge Type A] [Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B] [Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D]**.
- a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.
 - a) Finish steel edges and astragals with baked enamel **[same color as doors]**.
 - b) Finish steel edges and astragals to match door hardware (locksets or exit devices).
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: **[550 lbf] [475 lbf] [400 lbf]** in accordance with WDMA T.M. 10.

7. Core for Non-Fire-Rated Doors:
- a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
 - 1) Blocking: Provide wood blocking in particleboard-core doors as **[needed to eliminate through-bolting hardware.] [follows:]**
 - a) 5-inch top-rail blocking, in doors indicated to have closers.
 - b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c) 5-inch midrail blocking, in doors indicated to have exit devices.
 - 2) Provide doors with **[glued-wood-stave] [or] [WDMA I.S. 10 structural-composite-lumber]** cores instead of particleboard cores for doors scheduled to receive exit devices in **[Section 08 71 00 "Door Hardware."]**
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
8. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
- a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) **[4-1/2-by-10-inch lock blocks] [5-inch midrail blocking]**, in doors indicated to have exit devices.
9. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.05 SOLID-CORE FIVE-PLY FLUSH WOOD DOORS AND TRANSOM PANELS FOR OPAQUE FINISH

- A. Exterior Doors, Solid-Core Five-Ply for Opaque Finish **<Insert drawing designation>**:
1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [as indicated on Drawings]**.
 2. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.

3. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 4. Faces: **[MDO] [Any closed-grain hardwood of mill option]**.
 - a. Apply MDO to [standard-thickness, closed-grain, hardwood face veneers] [or] [directly to high-density hardboard crossbands].
 5. Exposed Vertical and Top Edges: Any closed-grain hardwood.
 6. Core:
 - a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
 7. Construction: Five plies, hot-pressed, bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
 8. Adhesives: Type I in accordance with WDMA T.M. 6.
- B. Interior Doors, Solid-Core Five-Ply for Opaque Finish <Insert drawing designation>:
1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [Standard Duty] [as indicated on Drawings]**.
 2. Performance Grade by Location:
 - a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [Classrooms] [public toilets] [janitor's closets] [assembly spaces] [exits] [and] [patient rooms] <Insert locations> [and where indicated on Drawings].
 - b. ANSI/WDMA I.S. 1A Standard Duty: [Closets (not including janitor's closets)] [and] [private toilets] <Insert locations> [and where indicated on Drawings].
 3. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 4. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 5. Faces: **[MDO] [Any closed-grain hardwood of mill option] [Hardboard or MDF]**.
 - a. Apply MDO to [standard-thickness, closed-grain, hardwood face veneers] [or] [directly to high-density hardboard crossbands].
 - b. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
 - c. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.
 6. Exposed Vertical and Top Edges: Any closed-grain hardwood.

- a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.
 - a) Finish steel edges and astragals with baked enamel [**same color as doors**].
 - b) Finish steel edges and astragals to match door hardware (locksets or exit devices).
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: **[550 lbf] [475 lbf] [400 lbf]** in accordance with WDMA T.M. 10.
7. Core for Non-Fire-Rated Doors:
- a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
 - 1) Blocking: Provide wood blocking in particleboard-core doors as **[needed to eliminate through-bolting hardware.] [follows:]**
 - a) 5-inch top-rail blocking, in doors indicated to have closers.
 - b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c) 5-inch midrail blocking, in doors indicated to have exit devices.
 - 2) Provide doors with [glued-wood-stave] [or] [WDMA I.S. 10 structural-composite-lumber] cores instead of particleboard cores for doors scheduled to receive exit devices in [Section 08 71 00 "Door Hardware."] [Section 08 71 11 "Door Hardware (Descriptive Specification)."]
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
8. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

- a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) **[4-1/2-by-10-inch lock blocks] [5-inch midrail blocking]**, in doors indicated to have exit devices.
 - 9. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
- 2.06 SOLID-CORE SEVEN-PLY FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS FOR TRANSPARENT FINISH
- A. Exterior Doors, Seven-Ply Veneer-Faced <Insert drawing designation>:
- 1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [as indicated on Drawings]**.
 - 2. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 - 3. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 - 4. Faces: **[Single-ply wood veneer not less than 1/50 inch thick] [or] [two-ply wood panel with wood veneer not less than 1/50 inch thick]**.
 - a. Species: [Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>.
 - b. Cut: [Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut].
 - c. Match between Veneer Leaves: **[Book] [Slip] [Random]** match.
 - d. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
 - e. Pair and Set Match: Provide for doors hung in same opening **[or separated only by mullions]**.
 - 5. Exposed Vertical and Top Edges: **[Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A] [Same species as faces - Architectural Woodwork Standards edge Type A] [Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B] [Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D]**.
 - 6. Core:
 - a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.

- b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
7. Construction: Seven plies, **[hot-pressed] [or] [cold-pressed]** bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
8. Adhesives: Type I in accordance with WDMA T.M. 6.
- B. Interior Doors, Seven-Ply Veneer-Faced **<Insert drawing designation>**:
- 1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [Standard Duty] [as indicated on Drawings]**.
 - 2. Performance Grade by Location:
 - a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [Classrooms] [public toilets] [janitor's closets] [assembly spaces] [exits] [and] [patient rooms] <Insert locations> [and where indicated on Drawings].
 - b. ANSI/WDMA I.S. 1A Standard Duty: [Closets (not including janitor's closets)] [and] [private toilets] <Insert locations> [and where indicated on Drawings].
 - 3. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 - 4. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 - 5. Faces: **[Single-ply wood veneer not less than 1/50 inch thick] [or] [two-ply wood panel with wood veneer not less than 1/50 inch thick]**.
 - a. Species: [Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>.
 - b. Cut: [Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut].
 - c. Match between Veneer Leaves: **[Book] [Slip] [Random]** match.
 - d. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
 - e. Pair and Set Match: Provide for doors hung in same opening **[or separated only by mullions]**.
 - f. Room Match:
 - 1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by **[10 feet] [20 feet] <Insert dimension>** or more.

- 2) Provide door faces of compatible color and grain within each separate room or area of building.
 - g. Transom Match: [Continuous match] [End match] [As indicated on Drawings].
 - h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 06 42 16 "Flush Wood Paneling."
6. Exposed Vertical and Top Edges: **[Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A] [Same species as faces - Architectural Woodwork Standards edge Type A] [Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B] [Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D].**
- a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.
 - a) Finish steel edges and astragals with baked enamel **[same color as doors]**.
 - b) Finish steel edges and astragals to match door hardware (locksets or exit devices).
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: **[550 lbf] [475 lbf] [400 lbf]** in accordance with WDMA T.M. 10.
7. Core for non-fire-rated doors, ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
- a. Blocking: Provide wood blocking in particleboard-core doors as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking, in doors indicated to have closers.
 - 2) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - 3) 5-inch midrail blocking, in doors indicated to have exit devices.

- b. Provide doors with [glued-wood-stave] [or] [WDMA I.S. 10 structural-composite-lumber] cores instead of particleboard cores for doors scheduled to receive exit devices in [Section 08 71 00 "Door Hardware."] [Section 08 71 11 "Door Hardware (Descriptive Specification)."]
 - 8. Core for non-fire-rated doors, glued wood stave.
 - 9. Core for non-fire-rated doors, WDMA I.S. 10 structural composite lumber.
 - a. Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - b. Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - 10. Core for non-fire-rated doors, either glued wood stave or WDMA I.S. 10 structural composite lumber.
 - 11. Core for fire-rated doors, as required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) **[4-1/2-by-10-inch lock blocks] [5-inch midrail blocking]**, in doors indicated to have exit devices.
 - 12. Construction: Seven plies, **[hot-pressed] [or] [cold-pressed]**, bonded or unbonded.
- 2.07 SOLID-CORE SEVEN-PLY FLUSH WOOD DOORS AND TRANSOM PANELS FOR OPAQUE FINISH
- A. Exterior Doors, Seven-Ply for Opaque Finish <Insert drawing designation>:
 - 1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [as indicated on Drawings]**.
 - 2. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 - 3. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 - 4. Faces: **[MDO] [Any closed-grain hardwood of mill option]**.
 - a. Apply MDO to [standard-thickness, closed-grain, hardwood face veneers] [or] [directly to high-density hardboard crossbands].
 - 5. Exposed Vertical and Top Edges: Any closed-grain hardwood.
 - 6. Core:
 - a. ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.

- b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - 2) Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
7. Construction: Seven plies, **[hot-pressed] [or] [cold-pressed]**, bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
8. Adhesives: Type I in accordance with WDMA T.M. 6.
- B. Interior Doors, Seven-Ply for Opaque Finish **<Insert drawing designation>**:
- 1. Performance Grade: ANSI/WDMA I.S. 1A **[Extra Heavy Duty] [Heavy Duty] [Standard Duty] [as indicated on Drawings]**.
 - 2. Performance Grade by Location:
 - a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [Classrooms] [public toilets] [janitor's closets] [assembly spaces] [exits] [and] [patient rooms] <Insert locations> [and where indicated on Drawings].
 - b. ANSI/WDMA I.S. 1A Standard Duty: [Closets (not including janitor's closets)] [and] [private toilets] <Insert locations> [and where indicated on Drawings].
 - 3. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
 - 4. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
 - 5. Faces: **[MDO] [Any closed-grain hardwood of mill option] [Hardboard or MDF]**.
 - a. Apply MDO to [standard-thickness, closed-grain, hardwood face veneers] [or] [directly to high-density hardboard crossbands].
 - b. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
 - c. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.
 - 6. Exposed Vertical and Top Edges: Any closed-grain hardwood.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.

- a) Finish steel edges and astragals with baked enamel [**same color as doors**].
 - b) Finish steel edges and astragals to match door hardware (locksets or exit devices).
- c. Mineral Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: **[550 lbf] [475 lbf] [400 lbf]** in accordance with WDMA T.M. 10.
7. Core for non-fire-rated doors, ANSI A208.1, **[Grade LD-1] [Grade LD-2]** particleboard.
 - a. Blocking: Provide wood blocking in particleboard-core doors as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking, in doors indicated to have closers.
 - 2) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - 3) 5-inch midrail blocking, in doors indicated to have exit devices.
 - b. Provide doors with **[glued-wood-stave] [or] [WDMA I.S. 10 structural-composite-lumber]** cores instead of particleboard cores for doors scheduled to receive exit devices in **[Section 08 71 00 "Door Hardware."]**
8. Core for non-fire-rated doors, glued wood stave.
9. Core for non-fire-rated doors, WDMA I.S. 10 structural composite lumber.
 - a. Screw Withdrawal, Door Face: **[550 lbf] [475 lbf] [400 lbf]**.
 - b. Screw Withdrawal, Vertical Door Edge: **[550 lbf] [475 lbf] [400 lbf]**.
10. Core for non-fire-rated doors, either glued wood stave or WDMA I.S. 10 structural composite lumber.
11. Core for fire-rated doors, as required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as **[needed to eliminate through-bolting hardware.] [follows:]**
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) **[4-1/2-by-10-inch lock blocks] [5-inch midrail blocking]**, in doors indicated to have exit devices.
12. Construction: Seven plies, **[hot-pressed] [or] [cold-pressed]**, bonded or unbonded.

2.08 FIRE-RATED WOOD DOOR FRAMES

A. Interior Fire-Rated Door Frames:

1. ANSI/WDMA I.S. 1A Quality Grade: **[Premium] [Custom]**.
2. Architectural Woodwork Standards Quality Grade: **[Premium] [Custom]**.
3. Wood Species and Cut: Match species and cut indicated for wood doors unless otherwise indicated.
4. Species: **[Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>**.
5. Cut: **[Plain sliced/plain sawn] [Quarter cut/quarter sawn] [Rift cut/rift sawn]**.
6. Wood Moisture Content: **[5 to 10] [8 to 13] [4 to 9]** percent.
7. Profile: **[T-stop] [Flat] [Single rabbet] [Double rabbet] [As indicated on Drawings]**.
8. Construction: Solid lumber, fire-retardant particleboard, or fire-retardant medium density fiberboard (MDF) with veneered exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated on Drawings.

2.09 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: **[Same species as door faces] [Species compatible with door faces] [Any closed-grain hardwood]**.
2. Profile: **[Flush rectangular beads] [Recessed tapered beads] [Recessed tapered beads with exposed banding] [Lipped tapered beads] [Manufacturer's standard shape]**.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; **[factory primed for paint] [with baked-enamel- or powder-coated]** finish; and approved for use in doors of fire-protection rating indicated on Drawings.

D. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.

1. Wood Species: **[Same species as door faces] [Species compatible with door faces] [Any closed-grain hardwood]**.
2. Profile: **[Flat] [Chevron]**.

E. Metal Louvers:

1. Blade Type: **[Vision-proof, inverted V] [Vision-proof, inverted Y] [Darkroom-type, double inverted V]**.
 2. Metal and Finish:
 - a. Hot-dip galvanized steel, 0.040 inch thick, [factory primed for paint] [with baked-enamel- or powder-coated] finish.
 - b. Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.
 - c. Extruded aluminum with **[light bronze] [medium bronze] [dark bronze] [black]**, Class II, color anodic finish, AA-M12C22A32/A34.
- F. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
1. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, **[factory primed for paint] [with baked-enamel- or powder-coated]** finish.
- 2.10 FABRICATION
- A. Factory fit doors to suit frame-opening sizes indicated.
1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Transom and Side Panels:
1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
 2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
 3. Fabricate door and transom panels with full-width, solid-lumber **[, rabbeted,]** meeting rails.
 4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
- D. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.
- E. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before factory **[priming] [finishing]**.
1. Flash top of outswinging doors with manufacturer's standard metal flashing.
- 2.11 FACTORY PRIMING
- A. Doors for Opaque Finish: Factory prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in **[Section 09 91 13 "Exterior Painting.]"**
[Section 09 91 23" Interior Painting.]"
- 2.12 FACTORY FINISHING
- A. Comply with referenced quality standard for factory finishing.
1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 2. Finish faces, all four edges, edges of cutouts, and mortises.
 3. Stains and fillers may be omitted on **[top and]** bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Factory finish doors that are indicated on Drawings to receive transparent finish.
- D. Factory finish doors where indicated in schedules or on Drawings as factory finished.
- E. Transparent Finish:
1. Architectural Woodwork Standards Grade: **[Premium] [Custom]**.
 - a. System-5, Varnish, Conversion.
 - b. System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
 - c. System-10, UV Curable, Water Based.
 - d. System-11, Polyurethane, Catalyzed.
 2. ANSI/WDMA I.S. 1A Grade: **[Premium] [Custom]**.
 - a. TR-4 Conversion Varnish.
 - b. TR-6 Catalyzed Polyurethane.
 - c. TR-8 UV Cured Acrylated Polyester/Urethane.

3. Staining: **[Match Architect's sample] [As selected by Architect from manufacturer's full range] [None required]**.
4. Sheen: **[Satin] [Semigloss]**.

F. Opaque Finish:

1. Architectural Woodwork Standards Grade: **[Premium] [Custom]**.
 - a. System-5, Varnish, Conversion.
 - b. System-9, UV Curable, Acrylated Epoxy, Polyester, or Urethane.
 - c. System-10, UV Curable, Water Based.
 - d. System-11, Polyurethane, Catalyzed.
2. ANSI/WDMA I.S. 1A Grade: **[Premium] [Custom]**.
 - a. OP-4 Conversion Varnish.
 - b. OP-6 Catalyzed Polyurethane.
3. Color: **[Match Architect's sample] [As selected by Architect from manufacturer's full range]**.
4. Sheen: **[Satin] [Semigloss] [Gloss]**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Hardware: For installation, see **[Section 08 71 00 "Door Hardware."]**
- B. Install doors **[and frames]** to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 2. Anchor frames to anchors or blocking built in or directly attached to substrates.

- a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails **[or finishing screws]** for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
3. Install fire-rated doors and frames in accordance with NFPA 80.
 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Job-Fitted Doors:
1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
 - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
 2. Machine doors for hardware.
 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 4. Clearances:
 - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
 - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
 - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - d. Comply with NFPA 80 for fire-rated doors.
 5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 6. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- 3.03 FIELD QUALITY CONTROL
- A. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
1. Provide inspection of installed Work through **[AWI's Quality Certification Program] [WI's Certified Compliance Program]**, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI's "Architectural Woodwork Standards" for the specified grade.

2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
 - D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
 - E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in **[NFPA 80] [and] [NFPA 101]**.
- 3.04 ADJUSTING
- A. Operation: Rehang or replace doors that do not swing or operate freely.
 - B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 08 14 23

PLASTIC LAMINATE-FACED WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes high pressure decorative plastic laminate faced flush wood doors.

1.02 SUBMITTALS

- A. Data: Manufacturer product data for doors.
- B. Shop drawings: Show the following.
 - 1. Door schedule indicating opening identifying number, door type, grade, size, thickness, swing, label requirements, and undercuts.
 - 2. Door elevations indicating type of construction.
 - 3. Prefitting and premachining requirements, including hardware locations.
 - 4. Use same reference numbers for openings and details as Contract Drawings.
- C. Samples:
 - 1. Minimum 6-inch square samples of plastic laminate for each color and texture.
 - 2. Corner samples showing face veneer, edge and core construction for each type of door specified.
- D. Warranty: Warranty form from the door manufacturer.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain impact resistant Acrovyn Door Systems doors through one source from a single manufacturer.
- B. Quality Standard: Comply with WDMA Industry Standard (I.S. 1A-04 "Architectural Wood Flush Doors").
- C. Doors shall meet performance attributes for the following performance duty level: Extra Heavy Duty (Standard Duty for FC5-NR)
- D. Tolerances for warp, telegraphing, squareness and pre-fitting dimensions as per the latest edition of WDMA I.S.1A-04.
- E. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-ratings indicated, based on testing according to UBC Standard 7-2, UL-10C Positive Pressure and NFPA 252.
- F. Doors or trial doors of the type specified herein should be installed in an existing facility for over 6 months to verify quality and durability performance of product.

1.04 HANDLING

- A. Delivery:
 - 1. Deliver doors factory-wrapped in polyethylene bags, unitized and palletized. Shrink-wrap each pallet and provide corner guards for protection.
 - 2. Mark each door with architectural opening number in distribution and installation.
 - 3. Do not deliver doors to the Project until proper storage space is available.
- B. Storage:
 - 1. Store doors in an assigned space having controlled temperature and humidity as recommended by AWI, flat, on factory pallets or on 3 full 2 by 4s, one centered and the other two 12 inches from each end.
 - 2. Protect doors from construction activity with plywood and store away from direct sunlight.
- C. Handling:
 - 1. Handle doors with clean hands.
 - 2. Do not drag doors across one another.
 - 3. Maintain factory packaging or other means of protection of doors until Substantial Completion.

1.05 JOB CONDITIONS

- A. Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during remainder of construction period.
- B. Comply with applicable WI quality standards.

1.06 WARRANTY

- A. Provide manufacturer's warranty against doors delaminating, telegraphing core through face veneer or do not conform to tolerance limitations of referenced quality standards for 5 years after installation.
- B. Warranty shall also include reinstallation required due to repair or replacement of defective doors where defect was not apparent prior to hanging.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. CS Acrovyn doors by Construction Specialties, basis of design.
- B. Marlite.
- C. VT Industries.
- D. Or Equal.

2.02 DOORS

A. High pressure decorative laminate faced wood doors - General:

1. The following high pressure decorative laminate faced doors complying with WDMA "Extra Heavy Duty" classification, except that "Heavy Duty" classification may be used in spaces such as offices, closets and similar rooms.
2. Grade: Custom.
3. Type: PC-HPDL-3, 3-ply, bonded particleboard core.
4. Sealer: Seal top and bottom edges in the factory.

B. Door Face:

1. Acrovyn® Woodgrains or solid color impact resistant, PVC-free Acrovyn. Finish to be:_____.
2. Engineered PVC-free rigid sheet to be Acrovyn by Design: High-definition graphic file digitally printed on reverse side of clear sheet and sealed with protective backer. Either to be customer provided artwork with copyright clearance file, or one of Acrovyn by Design Pattern Collections. Specify color-matched caulk, clear caulk, Acrovyn trims or aluminum trims as needed for joints/transitions. Specific files used on the project are noted below. See floor plans and finish schedule for coordinating locations.
3. Face material base color must be integral throughout to eliminate discoloration caused by scratching.
4. Face Veneer Wear Index - Abrasion Resistance Testing - ASTM D4060-90: 28,000 cycles to prove out resistant to scuffing and scratching.
5. Face Veneer Impact Resistance - ASTM D-4226: 86 in/lb. (99.08kg/cm³) to confirm impact resistance of face finish.

C. Door Edges:

1. Edges are to fully wrap the door vertical stiles to eliminate banded edges thus improving durability and impact resistance.
2. Door edges shall be exclusive of fasteners to improve appearance.
3. Profile of edges shall be a minimum height/thickness of 3/4-inch for maximum durability and ease of replacement.
4. Edges must be flush with face of door thus eliminating raised edges that could be torn off.
5. Edges to include 1/4-inch radius edges to improve impact deflection. Square or banded edges should not be permitted.
6. Edges are to be extruded (not formed) to ensure correct appearance and proper door fit.
7. Edges to be provided as part of the construction of the door from single source manufacturer.

2.03 FABRICATION, GENERAL

- A. Doors shall be pre fit and beveled at the factory to fit the openings to reduce handling an onsite labor costs. Pre fit tolerances shall be in accordance with the requirements of WDMA I.S.1A-04, latest edition.
- B. For fire rated doors comply with clearance requirements of referenced quality standard for fitting in accordance with requirements listed in NFPA 80.

- C. Coordinate measurements of hardware mortises in metal frames. Contractor or door distributor to verify dimensions and alignment before factory machining.
- D. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame shop drawings, and hardware templates.
- E. Light openings must be cut by the manufacturer or by a certified machining distributor.
- F. Top and bottom rails shall be factory sealed with an approved wood sealer to eliminate moisture from entering core thus eliminating warp.
- G. Blocking: provide blocking approved for use in doors of fire ratings indicated as needed to eliminate through-bolting for surface applied hardware.

2.04 FACTORY-MACHINING DOORS

- A. Factory-machine doors by manufacturer or qualified distributor for cutouts, hinges, louvers, vision panels, locks and all hardware requiring routing or mortising.

2.05 ADHESIVES

- A. Crossbanding to core adhesives shall be Type II, urea formaldehyde free I to improve structural integrity of door.
- B. Door faces are to be applied to the crossbanded core using Type I, urea formaldehyde free adhesives to eliminate delamination.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine adjacent construction and supports.
- B. Verify that frames are within allowable tolerances, plumb, level, clean, will provide a solid anchoring surface.
- C. Correct condition's detrimental to the proper or timely completion of this work before proceeding with installation.

3.02 INSTALLING FINISH HARDWARE/HANGING DOORS

- A. Install finish hardware in compliance with its manufacturer's instructions and the requirements of Section 08 71 00.
- B. Install doors [and frames] to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.

- b. Use fine finishing nails [or finishing screws] for exposed fastening, countersunk and filled flush with woodwork.
- c. For factory-finished items, use filler matching finish of items being installed.
- 3. Install fire-rated doors and frames in accordance with NFPA 80.
- 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Condition doors to average prevailing humidity in installation area prior to hanging.
- E. Hang doors to operate freely for their entire travel, but not loosely, without sticking or hinge binding, with all hardware adjusted and functioning properly.
- F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Provide inspection of installed Work through WI's Certified Compliance Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI's "North American Architectural Woodwork Standards" for the specified grade.
 - 2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
- C. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- D. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- E. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- F. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [NFPA 80] [and] [NFPA 101].

3.04 REPLACING DAMAGED DOORS

- A. Replace doors showing chips, scratches, unbonded face veneers, glue stains, excessive warp or other damage that cannot be satisfactorily repaired, as determined by the Architect, with acceptable doors.

END OF SECTION

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SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Access doors and frames.
2. Fire-rated access doors and frames.

B. Related Requirements:

1. Section 07 72 00 "Roof Accessories" for roof hatches.
2. Section 08 31 13.53 "Security Access Doors and Frames" for access doors and frames for security applications.
3. Section 08 31 23 "Floor Doors" for doors installed in floors.
4. Section 23 33 00 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.02 ALLOWANCES

- A. Access doors and frames are part of an access door and frame allowance.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details **[, fire ratings,]** material descriptions, dimensions of individual components and profiles, and finishes.

- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.

- C. Product Schedule: For access doors and frames. **[Use same designations indicated on Drawings.]**

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

1.05 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.06 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies meets the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection [**and temperature-rise limit**] ratings indicated, according to NFPA 252 or UL 10B.

2.02 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges <Insert drawing designation>:
 - 1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 2. Optional Features: [Gasketing] [Double-leaf doors] [Piano hinges] [Louvers] [Masonry anchors] [Removable doors] <Insert feature>.
 - 3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
 - 4. Door Size: <Insert door size>.
 - 5. Uncoated Steel Sheet for Door: [Nominal **0.060 inch**, 16 gage] <Insert thickness>, factory [primed] [finished].
 - 6. Metallic-Coated Steel Sheet for Door: [Nominal **0.064 inch**, 16 gage] <Insert thickness>, factory [primed] [finished].
 - 7. Stainless Steel Sheet for Door: [Nominal **0.062 inch**, 16 gage] <Insert thickness>, ASTM A480/A480M No. 4 finish.
 - 8. Frame Material: [Same material, thickness, and finish as door] <Insert material, thickness, and finish>.

9. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [Cam latch, hex-head wrench operated] [Cam latch, pinned-hex-head wrench operated] [Cam latch, spanner-head wrench operated] [Latch bolt, knurled-knob operated] [Latch bolt, key operated] [Prepared for mortise cylinder] [As indicated on Drawings] [As indicated in schedule] <Insert operator> [with interior release].

B. Flush Access Doors with Concealed Flanges <Insert drawing designation>:

1. Description: Face of door flush with frame; with concealed flange for [gypsum board] [plaster] installation and concealed hinge.
2. Optional Features: [Gasketing] [Double-leaf doors] [Piano hinges] [Louvers] [Masonry anchors] [Removable doors] <Insert feature>.
3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
4. Door Size: <Insert door size>.
5. Uncoated Steel Sheet for Door: [Nominal 0.060 inch, 16 gage] <Insert thickness>, factory [primed] [finished].
6. Metallic-Coated Steel Sheet for Door: [Nominal 0.064 inch, 16 gage] <Insert thickness> factory [primed] [finished].
7. Stainless Steel Sheet for Door: [Nominal 0.062 inch, 16 gage] <Insert thickness>, ASTM A480/A480M No. 4 finish.
8. Frame Material: [Same material and thickness as door] <Insert material, thickness, and finish>.
9. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [Cam latch, hex-head wrench operated] [Cam latch, pinned-hex-head wrench operated] [Cam latch, spanner-head wrench operated] [Latch bolt, knurled-knob operated] [Latch bolt, key operated] [Prepared for mortise cylinder] [As indicated on Drawings] [As indicated in schedule] <Insert operator> [with interior release].

C. Recessed Access Doors with Exposed Flanges<Insert drawing designation>:

1. Description: Door face recessed [1/2 inch] [5/8 inch] [1 inch] for [gypsum board] [plaster] [acoustical tile] <Insert material> infill, with exposed flange and concealed hinge.
2. Optional Features: [Gasketing] [Double-leaf doors] [Piano hinges] [Louvers] [Masonry anchors] [Removable doors] <Insert feature>.
3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
4. Door Size: <Insert door size>.
5. Uncoated Steel Sheet for Door: [Nominal 0.060 inch, 16 gage] <Insert thickness>, factory [primed] [finished].

6. Metallic-Coated Steel Sheet for Door: **[Nominal 0.064 inch, 16 gage]** <Insert **thickness**>, factory **[primed]** **[finished]**.
 7. Stainless Steel Sheet for Door: **[Nominal 0.062 inch, 16 gage]** <Insert **thickness**>, ASTM A480/A480M No. 4 finish.
 8. Frame Material: **[Same material and thickness as door]** <Insert material, thickness, and finish>.
 9. Latch and Lock: **[Cam latch, screwdriver operated]** **[Cam latch, key operated]** **[Cam latch, hex-head wrench operated]** **[Cam latch, pinned-hex-head wrench operated]** **[Cam latch, spanner-head wrench operated]** **[Latch bolt, knurled-knob operated]** **[Latch bolt, key operated]** **[Prepared for mortise cylinder]** **[As indicated on Drawings]** **[As indicated in schedule]** <Insert operator> **[with interior release]**.
- D. Recessed Access Doors with Concealed Flanges<Insert drawing designation>:
1. Description: Door face recessed **[1/2 inch]** **[5/8 inch]** **[1 inch]** for **[gypsum board]** **[plaster]** **[acoustical tile]** <Insert material> infill; with concealed flange for **[gypsum board]** **[plaster]** **[no bead for acoustical tile]** installation and concealed hinge.
 2. Optional Features: **[Gasketing]** **[Double-leaf doors]** **[Piano hinges]** **[Louvers]** **[Masonry anchors]** **[Removable door]** <Insert feature>.
 3. Locations: **[Wall]** **[Ceiling]** **[Wall and ceiling]** <Insert location or substrate>.
 4. Door Size: <Insert door size>.
 5. Uncoated Steel Sheet for Door: **[Nominal 0.060 inch, 16 gage]** <Insert thickness>, factory **[primed]** **[finished]**.
 6. Metallic-Coated Steel Sheet for Door: **[Nominal 0.064 inch, 16 gage]** <Insert **thickness**>, factory **[primed]** **[finished]**.
 7. Stainless Steel Sheet for Door: **[Nominal 0.062 inch, 16 gage]** <Insert thickness>, **[ASTM A480/A480M No. 4]** **[ASTM A480/A480M No. 2b]** finish.
 8. Latch and Lock: **[Cam latch, screwdriver operated]** **[Cam latch, key operated]** **[Cam latch, hex-head wrench operated]** **[Cam latch, pinned-hex-head wrench operated]** **[Cam latch, spanner-head wrench operated]** **[Latch bolt, knurled-knob operated]** **[Latch bolt, key operated]** **[Prepared for mortise cylinder]** **[As indicated on Drawings]** **[As indicated in schedule]** <Insert operator> **[with interior release]**.
- E. Aluminum Flush Access Doors <Insert drawing designation>:
1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 2. Optional Features: **[Gasketing]** **[Double-leaf doors]** **[Piano hinges]** **[Louvers]** **[Masonry anchors]** **[Removable doors]** <Insert feature>.
 3. Locations: **[Wall]** **[Ceiling]** **[Wall and ceiling]** <Insert location or substrate>.
 4. Door Size: <Insert door size>.

5. Aluminum Sheet for Door: [Nominal **0.045 inch**] <Insert thickness>, with [mill] [manufacturer's standard baked-enamel or powder-coat] finish.
6. Frame Material: [Same material, thickness, and finish as door] <Insert material, thickness, and finish>.
7. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [Cam latch, hex-head wrench operated] [Cam latch, pinned-hex-head wrench operated] [Cam latch, spanner-head wrench operated] [Latch bolt, knurled-knob operated] [Latch bolt, key operated] [Prepared for mortise cylinder] [As indicated on Drawings] [As indicated in schedule] <Insert operator> [with interior release].

F. Lightweight Flush Access Doors <Insert drawing designation>:

1. Description: Face of door flush with exposed flange, with exposed piano hinge; frameless for surface installation.
2. Optional Features: [Gasketing] [Double-leaf doors] [Piano hinges] [Louvers] [Masonry anchors] [Removable door] <Insert feature>.
3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
4. Door Size: <Insert door size>.
5. Uncoated Steel Sheet for Door: [Nominal **0.018 inch**, 26 gage] <Insert thickness>, factory [primed] [finished].
6. Metallic-Coated Steel Sheet for Door: [Nominal **0.022 inch**, 26 gage] <Insert thickness>, factory [primed] [finished].
7. Frame Material: [Aluminum, nominal **0.045 inch**, mill finish] <Insert material, thickness, and finish>.
8. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [Cam latch, hex-head wrench operated] [Cam latch, pinned-hex-head wrench operated] [Cam latch, spanner-head wrench operated] [Latch bolt, knurled-knob operated] [Latch bolt, key operated] [Prepared for mortise cylinder] [As indicated on Drawings] [As indicated in schedule] <Insert operator> [with interior release].

G. Exterior Flush Access Doors <Insert drawing designation>:

1. Description: Weatherproof assembly, with face of door fit flush with frame and with exposed frame. Include extruded door gaskets and minimum 2-inch-thick fiberglass insulation.
2. Optional Features: [Piano hinges] [Removable doors] <Insert feature>.
3. Locations: [Wall] <Insert location or substrate>.
4. Door Size: <Insert door size>.
5. Metallic-Coated Steel Sheet for Door: [Nominal **0.064 inch**, 16 gage] <Insert thickness>, factory [primed] [finished].

6. Aluminum Sheet for Door: [Nominal **0.045 inch**] <Insert thickness>, with [mill] [manufacturer's standard baked-enamel or powder-coat] finish.
 7. Stainless Steel Sheet for Door: [Nominal **0.062 inch**, 16 gage] <Insert thickness>, [ASTM A480/A480M No. 4] [ASTM A480/A480M No. 2b] finish.
 8. Frame Material: [Same material, thickness, and finish as door] <Insert material, thickness, and finish>.
 9. Latch and Lock: Cam latch operated by handle, [without lock] [with keyed lock in handle] [with separate mortise lock] [with preparation for mortise lock] [as indicated on Drawings] [as indicated in schedule] <Insert operator> [; with interior release].
- H. Interior Flush GFRG Access Doors with Concealed Flanges <Insert drawing designation>:
1. Description: Face of [drop-in] [concealed-hinge] door flush with frame, with concealed flange for gypsum board installation.
 2. Optional Features: [Gasketing] [Piano hinges] <Insert feature>.
 3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
 4. Door Size: <Insert door size>.
 5. Door Type [Drop in, radius corner] [Drop in, square corner] [Concealed-hinge, radius corner] [Concealed-hinge, square corner].
 6. Door and Frame Material: Unpainted glass-fiber-reinforced gypsum, with frames reinforced for hardware and fastenings.
 7. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [As indicated on Drawings] [As indicated in schedule] <Insert operator>.
- I. Exterior Flush GFRC Access Doors with Concealed Flanges <Insert drawing designation>:
1. Description: Face of door flush with frame, neoprene gasketed, with concealed flange for gypsum board installation.
 2. Optional Features: [Piano hinges] <Insert feature>.
 3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
 4. Door Size: <Insert door size>.
 5. Door Type: [Drop in, radius corner] [Drop in, square corner] [Concealed-hinge, radius corner] [Concealed-hinge, square corner].
 6. Door and Frame Material: Unpainted glass-fiber-reinforced cement, with frames reinforced for hardware and fastenings.

7. Latch and Lock: [Cam latch, screwdriver operated] [Cam latch, key operated] [Cam latch, hex-head wrench operated] [Cam latch, pinned-hex-head wrench operated] [As indicated on Drawings] [As indicated in schedule] <Insert operator>.

2.03 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, **[Flush] [Recessed]** Access Doors with Exposed Flanges <Insert drawing designation>:

1. Description: Door face flush with frame, **[with a core of mineral-fiber insulation enclosed in sheet metal] [uninsulated]**; with exposed flange, self-closing door, and concealed hinge.
2. Optional Features: [Upward-opening doors for ceilings] [Gasketing] [Double-leaf doors] [Piano hinges] [Masonry anchors] <Insert feature>.
3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.
4. Door Size: <Insert door size>.
5. Fire-Resistance Rating: Not less than [that indicated] [that of adjacent construction] [45 minutes] [1 hour] [1-1/2 hours] [2 hours] [3 hours] <Insert requirement>.
6. Temperature-Rise Rating: **[450 deg F] [250 deg F]** at the end of 30 minutes.
7. Uncoated Steel Sheet for Door: [Nominal **0.036 inch**, 20 gage] <Insert thickness>, factory [primed] [finished].
8. Metallic-Coated Steel Sheet for Door: **[Nominal 0.040 inch, 20 gage]** <Insert thickness>, factory [primed] [finished].
9. Stainless Steel Sheet for Door: **[Nominal 0.038 inch, 20 gage]** <Insert thickness>, ASTM A480/A480M No. 4 finish.
10. Frame Material: [Same material, thickness, and finish as door] <Insert material, thickness, and finish>.
11. Latch and Lock: Self-latching door hardware, [operated by knurled-knob] [operated by key] [prepared for mortise cylinder] [as indicated on Drawings] [as indicated in schedule] <Insert operator> [with interior release].

B. Fire-Rated, **[Flush] [Recessed]** Access Doors with Concealed Flanges <Insert drawing designation>:

1. Description: Door face flush with frame, **[with a core of mineral-fiber insulation enclosed in sheet metal] [uninsulated]**; with concealed flange for **[gypsum board] [plaster]** installation, self-closing door, and concealed hinge.
2. Optional Features: [Upward-opening doors for ceilings] [Gasketing] [Double-leaf doors] [Piano hinges] [Masonry anchors] <Insert feature>.
3. Locations: [Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>.

4. Door Size: <Insert door size>.
5. Fire-Resistance Rating: Not less than [that indicated] [that of adjacent construction] [45 minutes] [1 hour] [1-1/2 hours] [2 hours] [3 hours] <Insert requirement>.
6. Temperature-Rise Rating: [450 deg F] [250 deg F] at the end of 30 minutes.
7. Uncoated Steel Sheet for Door: [Nominal 0.036 inch, 20 gage] <Insert thickness>, factory [primed] [finished].
8. Metallic-Coated Steel Sheet for Door: [Nominal 0.040 inch, 20 gage] <Insert thickness>, factory [primed] [finished].
9. Stainless Steel Sheet for Door: [Nominal 0.038 inch, 20 gage] <Insert thickness>, ASTM A480/A480M No. 4 finish.
10. Frame Material: [Same material, thickness, and finish as door] <Insert material, thickness, and finish>.
11. Latch and Lock: Self-closing, self-latching door hardware, [operated by knurled-knob] [operated by key] [prepared for mortise cylinder] [as indicated on Drawings] [as indicated in schedule] <Insert operator> [, with interior release].

2.04 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [Type 304] [Type 316]. Remove tool and die marks and stretch lines, or blend into finish.
- E. Stainless Steel Flat Bars: ASTM A666, [Type 304] [Type 316]. Remove tool and die marks and stretch lines, or blend into finish.
- F. Aluminum Extrusions: ASTM B221, Alloy 6063.
- G. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- H. Frame Anchors: Same material as door face.
- I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.05 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 - 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
 - 1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in **[Section 08 71 00 "Door Hardware."]** **[Section 08 71 11 "Door Hardware (Descriptive Specification)."]**
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.06 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.

- a. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors] <Insert color>.

E. Stainless Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in **[NFPA 80] [and] [NFPA 101]**.

3.04 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

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SECTION 08 33 13

COILING COUNTER DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Overhead counter door assemblies.
2. Fire-rated overhead counter door assemblies.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for door-opening framing and corner guards.
2. Section 09 91 23 "Interior Painting" for finish painting of factory-primed doors.

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of coiling counter door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Show locations of controls, locking devices, [**detectors or replaceable fusible links**], and other accessories.
5. Include diagrams for power, signal, and control wiring.

- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Curtain slats [, including full vision window secured to slat].
 - 2. Bottom bar [with sensor edge].
 - 3. Guides.
 - 4. Brackets.
 - 5. Hood.
 - 6. Laminate-clad counter panel product for each type, color, pattern, and surface finish; laminated to core.
 - 7. Locking device(s).
 - 8. Include similar Samples of accessories involving color selection.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [and] [testing and inspecting agency].
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
 - 2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For coiling counter doors to include in maintenance manuals.
- B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than **[two]** <Insert number> hours' normal travel time from Installer's place of business to Project site.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain coiling counter doors from single source from single manufacturer.
 1. Obtain operators and controls from coiling counter door manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to **[NFPA 252]** **[or]** **[UL 10B]**.
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: **[Where indicated]** **[At exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
 3. Smoke Control: **[Where indicated]** **[In corridors and smoke barriers]**, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10 inch wg for both ambient and elevated temperature tests.
- B. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

2.03 COUNTER DOOR ASSEMBLY <Insert drawing designation>

- A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.

- B. Operation Cycles: Door components and operators capable of operating for not less than **[10,000] [20,000] [50,000] [100,000] [200,000]** <Insert number>. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
1. Include tamperproof cycle counter.
- C. STC Rating: **[26]** <Insert value>.
- D. Curtain R-Value: **[4.5 deg F x h x sq. ft./Btu] [5.0 deg F x h x sq. ft./Btu] [6.0 deg F x h x sq. ft./Btu]** <Insert value>.
- E. Door Curtain Material: **[Galvanized steel] [Stainless steel] [Aluminum]**.
- F. Door Curtain Slats: **[Curved] [Flat]** profile slats of **[1-1/4-inch] [1-1/2-inch]** <Insert dimension> center-to-center height.
1. Perforated Slats: Approximately **[1/16-inch pinholes] [3/32-inch pinholes] [7/8-inch-wide by 3/8-inch-high slots]** <Insert dimensions>.
 2. Fenestrated Slats: Approximately **[3- by 5/8-inch] [4- by 5/8-inch] [10- by 1-5/8-inch]** <Insert dimensions> openings spaced approximately **[1-1/2 inches]** <Insert dimension> apart and beginning 12 inches from jamb guides.
 3. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in **[two] [three]** <Insert number> rows of slats at height indicated on Drawings; installed with **[insulated]** vision-panel glazing.
 4. Insulated-Slat Interior Facing: **[Metal] [Plastic]**.
 5. Gasket Seal. Manufacturer's standard continuous gaskets between slats.
- G. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, fabricated **[hot-dip galvanized steel] [stainless steel] [or] [aluminum extrusion]** and finished **[to match door]** <Insert requirement>.
- H. Curtain Jamb Guides: **[Galvanized steel] [Stainless steel] [Aluminum]** with exposed finish matching curtain slats. **[Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.] [Provide removable post(s) and jamb guides where indicated on Drawings.]**
- I. Hood: **[Match curtain material and finish] [Galvanized steel] [Stainless steel] [Aluminum]**.
1. Shape: **[Round] [Square] [As indicated on Drawings]** <Insert shape>.
 2. Mounting: **[Face of wall] [Between jambs] [As indicated on Drawings]**.
- J. Integral Frame, Hood, and Fascia: **[Galvanized] [Stainless]** steel.

1. Mounting: [Face of wall] [Between jambs] [As indicated on Drawings].
- K. Sill Configuration: [No sill] [Integral metal sill].
- L. Locking Devices: Equip door with [slide bolt for padlock] [locking device assembly] [and] [chain lock keeper].
1. Locking Device Assembly: [Single-jamb side] [Cremona-type, both jamb sides] locking bars, operable from [inside with thumbturn] [outside with cylinder] [outside only, with cylinder] [inside and outside with cylinders] <Insert requirement>.
- M. Manual Door Operator: [Push-up operation] [Chain-hoist operator] [Manufacturer's standard crank operator] [Awning-crank operator].
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.
- N. Electric Door Operator:
1. Usage Classification: [Heavy duty, 25 or more cycles per hour and more than 90 cycles per day] [Standard duty, up to 25 cycles per hour and up to 90 cycles per day] [Medium duty, up to 12 cycles per hour and up to 50 cycles per day] [Light duty, up to 10 cycles per hour] <Insert classification>.
 2. Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 3. Motor Exposure: [Interior] [Exterior, wet, and humid].
 4. Motor Electrical Characteristics:
 - a. Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - b. Voltage:
 - 1) [115-V ac] [208-V ac] [230-V ac], single phase, 60 Hz.
 - 2) [208-V ac] [230-V ac] [460-V ac], three phase, 60 Hz.
 5. Emergency Manual Operation: [Push-up] [Chain] [Crank] type.
 6. Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - a. Sensor Edge Bulb Color: [Black] [As selected by Architect from manufacturer's full range] <Insert color>.

7. Control Station(s): [Interior-side mounted] [Exterior-side mounted] [Where indicated on Drawings] <Insert location>.
 8. Other Equipment: <Insert device>.
- O. Curtain Accessories: Equip door with [smoke seals] [weatherseals] [astragal] [push/pull handles] [pull-down strap] [pole hook] [and] [automatic closing device] <Insert item>.
- P. Door Finish:
1. Aluminum Finish: [Mill] [Clear anodized] [Light bronze anodized] [Medium bronze anodized] [Dark bronze anodized] [Black anodized] [Anodized color matching Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] <Insert color>.
 2. Baked-Enamel or Powder-Coated Finish: [Color as indicated by manufacturer's designations] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] <Insert color>.
 3. Factory Prime Finish: Manufacturer's standard color.
 4. Stainless Steel Finish: [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 4 (polished directional satin)] <Insert finish>.
 5. Interior Curtain-Slat Facing: [Match finish of exterior curtain-slat face] [PVC plastic] <Insert finish>.
- 2.04 FIRE-RATED COUNTER DOOR ASSEMBLY <Insert drawing designation>
- A. Fire-Rated Counter Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
 - B. Operation Cycles: Door components and operators capable of operating for not less than [10,000] [20,000] [50,000] [100,000] [200,000] <Insert number>. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 1. Include tamperproof cycle counter.
 - C. Fire Rating: [3/4 hour] [1 hour] [1-1/2 hours] [3 hours] [4 hours] [with temperature-rise limit] [and] [with smoke control].
 - D. STC Rating: [27] <Insert value>.
 - E. Curtain R-Value: [4.5 deg F x h x sq. ft./Btu] [5.0 deg F x h x sq. ft./Btu] [6.0 deg F x h x sq. ft./Btu] <Insert value>.
 - F. Door Curtain Material: [Galvanized] [Stainless] steel.

- G. Door Curtain Slats: **[Curved]** **[Flat]** profile slats of **[1-1/4-inch]** **[1-1/2-inch]** **<Insert dimension>** center-to-center height.
1. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in **[two]** **[three]** **<Insert number>** rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
 2. Insulated-Slat Interior Facing: Metal.
- H. Curtain Jamb Guides: **[Galvanized]** **[Stainless]** steel with exposed finish matching curtain slats.
- I. Hood: **[Match curtain material and finish]** **[Galvanized steel]** **[Stainless steel]**.
1. Shape: **[Round]** **[Square]** **[As indicated on Drawings]** **<Insert shape>**.
 2. Mounting: **[Face of wall]** **[Between jambs]** **[As indicated on Drawings]**.
- J. Integral Frame, Hood, and Fascia: **[Galvanized]** **[Stainless]** steel.
1. Mounting: **[Face of wall]** **[Between jambs]** **[As indicated on Drawings]**.
- K. Sill Configuration: **[No sill]** **[Integral metal sill]** **[Fire-rated, laminate counter]**.
1. High-Pressure Decorative Laminate: Match color, pattern, and finish **[as indicated by manufacturer's designations]** **[of Architect's sample]** **[as selected by Architect from manufacturer's full range]** **<Insert requirement>**.
- L. Locking Devices: Equip door with **[slide bolt for padlock]** **[locking device assembly]** **[and]** **[chain lock keeper]**.
1. Locking Device Assembly: **[Single-jamb side]** **[Cremona-type, both jamb sides]** locking bars, operable from **[inside with thumbturn]** **[outside with cylinder]** **[outside only, with cylinder]** **[inside and outside with cylinders]** **<Insert requirement>**.
- M. Manual Door Operator: **[Push-up operation]** **[Chain-hoist operator]** **[Manufacturer's standard crank operator]** **[Awning-crank operator]**.
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.
- N. Electric Door Operator:
1. Usage Classification: **[Heavy duty, 25 or more cycles per hour and more than 90 cycles per day]** **[Standard duty, up to 25 cycles per hour and up to 90 cycles per day]** **[Medium duty, up to 12 cycles per hour and up to 50 cycles per day]** **[Light duty, up to 10 cycles per hour]** **<Insert classification>**.

2. Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 3. Motor Exposure: [Interior] [Exterior, wet, and humid].
 4. Motor Electrical Characteristics:
 - a. Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - b. Voltage:
 - 1) [115-V ac] [208-V ac] [230-V ac], single phase, 60 Hz.
 - 2) [208-V ac] [230-V ac] [460-V ac], three phase, 60 Hz.
 5. Emergency Manual Operation: [Push-up] [Chain] [Crank] type.
 6. Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - a. Sensor Edge Bulb Color: [Black] [As selected by Architect from manufacturer's full range] <Insert color>.
 7. Control Station(s): [Interior-side mounted] [Exterior-side mounted] [Where indicated on Drawings] <Insert location>.
 8. Other Equipment: <Insert device>.
- O. Curtain Accessories: Equip door with smoke seals, automatic closing device, **[astragal]** **[push/pull handles]** **[pull-down strap]** **[pole hook]** **[and]** <Insert item>.
- P. Door Finish:
1. Baked-Enamel or Powder-Coated Finish: [Color as indicated by manufacturer's designations] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] <Insert color>.
 2. Factory Prime Finish: Manufacturer's standard color.
 3. Stainless Steel Finish: [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 4 (polished directional satin)] <Insert finish>.
 4. Interior Curtain-Slat Facing: [Match finish of exterior curtain-slat face] <Insert finish>.
- 2.05 MATERIALS, GENERAL
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.06 DOOR CURTAIN MATERIALS AND FABRICATION

- A. Door Curtains: Fabricate coiling counter door curtain of interlocking metal slats in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
 2. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of 0.025 inch; and as required.
 3. Aluminum Door Curtain Slats: ASTM B209 sheet or ASTM B221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.
 4. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
 5. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
 6. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
 7. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of **[25] [75] [200]** and smoke-developed index of 450, according to ASTM E84 or UL 723.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.
1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.07 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Galvanized Steel: Nominal 0.028-inch-thick, hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.

2. Stainless Steel: 0.025-inch-thick, stainless steel sheet, Type 304, complying with ASTM A240/A240M or ASTM A666.
 3. Aluminum: 0.040-inch-thick aluminum sheet complying with ASTM B209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
 4. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
- B. Integral Frame, Hood, and Fascia: Welded sheet metal assembly of the following sheet metal(s):
1. Galvanized Steel: Hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.
 2. Stainless Steel: Type 304, complying with ASTM A240/A240M or ASTM A666.
- C. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.08 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: As [specified in Section 08 71 00 "Door Hardware"] [standard with manufacturer] [and keyed to building keying system].
 2. Keys: [Two] [Three] <Insert number> for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.09 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.
- B. Weatherseals: Equip door with weather-stripping gaskets fitted to entire perimeter of door for air-resistant installation unless otherwise indicated.
1. At door head, use 1/8-inch-thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.

2. At door jambs, use replaceable, adjustable, continuous, [flexible, **1/8-inch**-thick seals of flexible vinyl, rubber, or neoprene] [nylon brushes] <Insert material>.
- C. Astragal: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
- D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
- E. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.
- F. Pole Hooks: Provide pole hooks and poles for doors more than 84 inches high.
- G. Automatic-Closing Device: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. [**Testing for manually operated doors allows resetting by opening the door without re-tensioning the counterbalance mechanism.**] [**Release mechanism for motor-operated doors allows testing without mechanical release of the door.**] Automatic-closing device is to be designed for activation by the following:
 1. Replaceable fusible links with temperature rise and melting point of [**165 deg F**] <Insert temperature> interconnected and mounted on both sides of door opening.
 2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
 3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
 4. Building fire-detection, smoke-detection, and -alarm systems.
- H. <Insert requirements>.

2.010 COUNTER DOOR ACCESSORIES

- A. Integral Metal Sill: Fabricate sills as integral part of frame assembly of Type 304 stainless steel in manufacturer's standard thickness with [**ASTM A480/A480M No. 4**] <Insert finish> finish.
- B. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure, decorative laminate-covered countertop; UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.
- C. <Insert requirements>.

2.011 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, **[seamless]** **[or]** **[welded]** carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
 - 1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic closing device operates.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.012 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Push-up Door Operation: Design counterbalance mechanism so that required lift or pull for door operation does not exceed **[25 lbf]** **<Insert value>**.
- C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum **[25-lbf]** **[30-lbf]** **<Insert value>** force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
- D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than **[25-lbf]** **[30-lbf]** **<Insert value>** force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.013 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-rewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

- C. Door Operator Location(s): Operator location indicated for each door.
1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
 2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
 3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
 4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
 5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.
- D. Motors: Reversible-type motor **[with controller (disconnect switch)]** for motor exposure indicated for each door assembly.
1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. **[For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.] [For fire-rated doors, activation delays closing.]**
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.

2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Type: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed **[25 lbf] [30 lbf] <Insert value>**.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. <Insert requirements>.
- 2.014 GENERAL FINISH REQUIREMENTS
- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
 - B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- 2.015 ALUMINUM FINISHES
- A. Mill Finish: Manufacturer's standard.
 - B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm]** or thicker.
 - C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.

- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.016 STEEL AND GALVANIZED-STEEL FINISHES

- A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- C. <Insert requirements>.

2.017 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M No. 4.
- C. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install coiling counter doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

- B. Install coiling counter doors, hoods, controls, and operators at the mounting locations indicated for each door.
- C. Fire-Rated Doors: Install according to NFPA 80.
- D. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections and to furnish reports to Architect.
- B. Perform the following tests and inspections [with the assistance of a factory-authorized service representative]:
 - 1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
 - 2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in **[NFPA 80] [and] [NFPA 101]**.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.05 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

- C. Adjust seals to provide tight fit around entire perimeter.

3.06 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service is to include **[three] [six] [nine] [12]** months' full maintenance by skilled employees of coiling-door Installer. Include **[monthly] [quarterly]** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain coiling counter doors.

END OF SECTION

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SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Service doors.
2. Insulated service doors.
3. Fire-rated service doors.
4. Fire-rated, insulated service doors.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.
2. [Section 09 90 00 "Painting"] [and] [Section 099600 "High-Performance Coatings"] for finish painting of factory-primed grilles.
3. Section 11 12 00 "Parking Control Equipment" for parking control equipment interlocked to overhead coiling doors.

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
 5. Show locations of controls, locking devices [**detectors or replaceable fusible links**], and other accessories.
 6. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
1. Curtain slats [, including full vision window secured to slat].
 2. Bottom bar [with sensor edge].
 3. Guides.
 4. Brackets.
 5. Hood.
 6. Locking device(s).
 7. Include similar Samples of accessories involving color selection.
- 1.03 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For [**Installer**] [**and**] [**testing and inspecting agency**].
1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.
- C. Sample Warranty: For special warranty.
- 1.04 CLOSEOUT SUBMITTALS
- A. Special warranty.
- B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.
- C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.
- 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
 - 1. Maintenance Proximity: Not more than **[two]** <Insert number> hours' normal travel time from Installer's place of business to Project site.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAl) certification.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **[Two]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
 - 1. Obtain operators and controls from overhead coiling-door manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to **[NFPA 252]** [or] **[UL 10B]**.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: **[Where indicated]** **[At exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
 - 3. Smoke Control: **[Where indicated]** **[In corridors and smoke barriers]**, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10 inch wg for both ambient and elevated temperature tests.
- B. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

- C. Accessibility Standard: Comply with applicable provisions in **[the USDOJ's "2010 ADA Standards for Accessible Design"] [the ABA standards of the Federal agency having jurisdiction] [and] [ICC A117.1] <Insert requirement>**.
- D. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:
1. Design Wind Load: **[As indicated on Drawings] [Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward] <Insert loads>**.
 2. Testing: According to ASTM E330/E330M **[or DASMA 108 for garage doors and complying with acceptance criteria of DASMA 108] <Insert requirement>**.
 3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
 4. Operability under Wind Load: Design overhead coiling doors to remain operable under **[design] [uniform pressure (velocity pressure) of 20-lbf/sq. ft.] <Insert load>** wind load, acting inward and outward.
- E. Windborne-Debris Impact Resistance: Provide **[glazed] [and] [impact-protective]** overhead coiling doors that pass ASTM E1886 missile-impact and cyclic-pressure tests according to **[ASTM E1996 for Wind Zone 1] [ASTM E1996 for Wind Zone 2] [ASTM E1996 for Wind Zone 3] [ASTM E1996 for Wind Zone 4] [or DASMA 115]** for **[basic] [enhanced]** protection.
1. Large-Missile Test: For overhead coiling doors located within **[30 ft.] <Insert dimension>** of grade.
 2. Small-Missile Test: For overhead coiling doors located between 30 ft. and **[60 ft.] <Insert dimension>** above grade.
- F. Seismic Performance: Overhead coiling doors are to withstand the effects of earthquake motions determined according to **[ASCE/SEI 7] <Insert requirement>**.
1. Component Importance Factor: **[1.5] [1.0]**.
- 2.03 DOOR ASSEMBLY <Insert drawing designation>
- A. **[Service] [Insulated Service]** Door: Overhead coiling door formed with curtain of interlocking metal slats.
- B. Operation Cycles: Door components and operators capable of operating for not less than **[10,000] [20,000] [50,000] [100,000] [200,000] <Insert number>**. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
1. Include tamperproof cycle counter.
- C. Air Infiltration: Maximum rate of **[0.4 cfm/sq. ft.] [1.0 cfm/sq. ft.] <Insert rate>** at 15 and 25 mph when tested according to **[ASTM E283] [or] [DASMA 105]**.
- D. STC Rating: **[26] <Insert value>**.

- E. Insulated Door Curtain R-Value: **[4.5 deg F x h x sq. ft./Btu]** <Insert value>.
- F. Insulated Door Assembly U-Factor: **[0.90 Btu/deg F x h x sq. ft.]** <Insert value>.
- G. Door Curtain Material: **[Galvanized steel]** **[Stainless steel]** **[Aluminum]**.
- H. Door Curtain Slats: **[Curved]** **[Flat]** profile slats of **[1-7/8-inch]** **[2-5/8-inch]** **[3-1/4-inch]** <Insert dimension> center-to-center height.
1. Perforated Slats: Approximately **[1/16-inch pinholes]** **[3/32-inch pinholes]** **[7/8-inch-wide by 3/8-inch-high slots]** <Insert dimensions>.
 2. Fenestrated Slats: Approximately **[3- by 5/8-inch]** **[4- by 5/8-inch]** **[10- by 1-5/8-inch]** <Insert dimensions> openings spaced approximately **[1-1/2 inches]** <Insert dimension> apart and beginning 12 inches from jamb guides.
 3. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in **[two]** **[three]** <Insert number> rows of slats at height indicated on Drawings; installed with **[insulated]** vision-panel glazing.
 4. Insulated-Slat Interior Facing: **[Metal]** **[Plastic]**.
 5. Gasket Seal. Manufacturer's standard continuous gaskets between slats.
- I. Bottom Bar: Two angles, each not less than **[1-1/2 by 1-1/2 by 1/8 inch thick]** <Insert dimensions>; fabricated from **[hot-dip galvanized steel]** **[stainless steel]** **[or]** **[aluminum extrusions]** and finished **[to match door]** <Insert requirement>.
- J. Curtain Jamb Guides: **[Galvanized steel]** **[Stainless steel]** **[Aluminum]** with exposed finish matching curtain slats.
- K. Pass Door(s): **[Hinged]** **[Rigid]** frame with **[lockset]** **[exit hardware]**.
- L. Hood: **[Match curtain material and finish]** **[Galvanized steel]** **[Stainless steel]** **[Aluminum]**.
1. Shape: **[Round]** **[Square]** **[As indicated on Drawings]** <Insert shape>.
 2. Mounting: **[Face of wall]** **[Between jambs]** **[As indicated on Drawings]**.
- M. Locking Devices: Equip door with **[slide bolt for padlock]** **[locking device assembly]** **[and]** **[chain lock keeper]**.
1. Locking Device Assembly: **[Single-jamb side]** **[Cremona-type, both jamb sides]** locking bars, operable from **[inside with thumbturn]** **[outside with cylinder]** **[outside only, with cylinder]** **[inside and outside with cylinders]** <Insert requirement>.
- N. Manual Door Operator: **[Push-up operation]** **[Chain-hoist operator]** **[Manufacturer's standard crank operator]** **[Awning-crank operator]** **[Wall-crank operator]**.
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.

- O. Electric Door Operator:
- Usage Classification: [Heavy duty, 25 or more cycles per hour and more than 90 cycles per day] [Standard duty, up to 25 cycles per hour and up to 90 cycles per day] [Medium duty, up to 12 cycles per hour and up to 50 cycles per day] [Light duty, up to 10 cycles per hour] <Insert classification>.
 - Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 - Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use [; moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. or lower].
 - Motor Exposure: [Interior] [Exterior, wet, and humid].
 - Motor Electrical Characteristics:
 - Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - Voltage: [115 V ac, single phase, 60 Hz] [208 V ac, single phase, 60 Hz] [230 V ac, single phase, 60 Hz] [208 V ac, three phase, 60 Hz] [230 V ac, three phase, 60 Hz] [460 V ac, three phase, 60 Hz].
 - Emergency Manual Operation: [Push-up] [Chain] [Crank] type.
 - Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - Sensor Edge Bulb Color: [Black] [As selected by Architect from manufacturer's full range] <Insert color>.
 - Control Station(s): [Interior mounted] [Exterior mounted] [Where indicated on Drawings] <Insert location>.
 - Other Equipment: [Audible and visual signals] [Portable radio-control system] <Insert device>.
- P. Curtain Accessories: Equip door with [smoke seals] [weatherseals] [astragal] [push/pull handles] [pull-down strap] [pole hook] [and] [automatic-closing device] <Insert item>.
- Q. Door Finish:
- Aluminum Finish: [Mill] [Clear anodized] [Light bronze anodized] [Medium bronze anodized] [Dark bronze anodized] [Black anodized] [Anodized color matching Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] <Insert color>.
 - Baked-Enamel or Powder-Coated Finish: [Color as indicated by manufacturer's designations] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] <Insert color>.
 - Factory Prime Finish: Manufacturer's standard color.

4. Stainless Steel Finish: [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 4 (polished directional satin)] <Insert finish>.
5. Interior Curtain-Slat Facing: [Match finish of exterior curtain-slat face] [Finish as indicated by manufacturer's designations] [Finish matching Architect's sample] [Finish as selected by Architect from manufacturer's full range] <Insert finish>.

2.04 FIRE-RATED DOOR ASSEMBLY <Insert drawing designation>

- A. Fire-Rated **[Service]** **[Insulated Service]** Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
- B. Operation Cycles: Door components and operators capable of operating for not less than **[10,000]** **[20,000]** **[50,000]** **[100,000]** **[200,000]** <Insert number>. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 1. Include tamperproof cycle counter.
- C. Fire Rating: **[3/4 hour]** **[1 hour]** **[1-1/2 hours]** **[3 hours]** **[4 hours]** **[with temperature-rise limit]** **[and]** **[with smoke control]**.
- D. Air Infiltration: Maximum rate of **[0.4 cfm/sq. ft.]** **[1.0 cfm/sq. ft.]** <Insert rate> at 15 and 25 mph when tested according to **[ASTM E283]** **[or]** **[DASMA 105]**.
- E. STC Rating: **[27]** <Insert value>.
- F. Insulated Door Curtain R-Value: **[4.5 deg F x h x sq. ft./Btu]** <Insert value>.
- G. Insulated Door Assembly U-Factor: **[0.90 Btu/deg F x h x sq. ft.]** <Insert value>.
- H. Door Curtain Material: **[Galvanized]** **[Stainless]** steel.
- I. Door Curtain Slats: **[Curved]** **[Flat]** profile slats of **[1-7/8-inch]** **[2-5/8-inch]** **[3-1/4-inch]** <Insert dimension> center-to-center height.
 1. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in **[two]** **[three]** <Insert number> rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
 2. Insulated-Slat Interior Facing: Metal.
- J. Bottom Bar: Two angles, each not less than **[1-1/2 by 1-1/2 by 1/8 inch thick]** <Insert dimensions>; fabricated from **[hot-dip galvanized steel]** **[stainless steel]** **[or]** **[aluminum extrusions]** and finished **[to match door]** <Insert requirement>.
- K. Curtain Jamb Guides: **[Galvanized]** **[Stainless]** steel with exposed finish matching curtain slats.
- L. Pass Door(s): **[Hinged]** **[Rigid]** frame with **[lockset]** **[exit hardware]**.
- M. Hood: **[Match curtain material and finish]** **[Galvanized steel]** **[Stainless steel]**.
 1. Shape: **[Round]** **[Square]** **[As indicated on Drawings]** <Insert shape>.

2. Mounting: [Face of wall] [Between jambs] [As indicated on Drawings].
- N. Locking Devices: Equip door with **[slide bolt for padlock] [locking device assembly] [and] [chain lock keeper]**.
1. Locking Device Assembly: [Single-jamb side] [Cremona-type, both jamb sides] locking bars, operable from [inside with thumbturn] [outside with cylinder] [outside only, with cylinder] [inside and outside with cylinders] <Insert requirement>.
- O. Manual Door Operator: **[Push-up operation] [Chain-hoist operator] [Manufacturer's standard crank operator] [Awning-crank operator] [Wall-crank operator]**.
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.
- P. Electric Door Operator:
1. Usage Classification: [Heavy duty, 25 or more cycles per hour and more than 90 cycles per day] [Standard duty, up to 25 cycles per hour and up to 90 cycles per day] [Medium duty, up to 12 cycles per hour and up to 50 cycles per day] [Light duty, up to 10 cycles per hour] <Insert classification>.
 2. Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; **[moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. or lower]**.
 4. Motor Exposure: [Interior] [Exterior, wet, and humid].
 5. Motor Electrical Characteristics:
 - a. Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - b. Voltage: **[115 V ac, single phase, 60 Hz] [208 V ac, single phase, 60 Hz] [230 V ac, single phase, 60 Hz] [208 V ac, three phase, 60 Hz] [230 V ac, three phase, 60 Hz] [460 V ac, three phase, 60 Hz]**.
 6. Emergency Manual Operation: **[Push-up] [Chain] [Crank]** type.
 7. Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - a. Sensor Edge Bulb Color: **[Black] [As selected by Architect from manufacturer's full range]** <Insert color>.
 8. Control Station(s): [Interior mounted] [Exterior mounted] [Where indicated on Drawings] <Insert location>.
 9. Other Equipment: [Audible and visual signals] [Portable radio-control system] <Insert device>.

- Q. Curtain Accessories: Equip door with smoke seals, automatic-closing device, **[astragal]** **[push/pull handles]** **[pull-down strap]** **[pole hook]** **[and]** **<Insert item>**.
- R. Door Finish:
1. Baked-Enamel or Powder-Coated Finish: **[Color as indicated by manufacturer's designations]** **[Color matching Architect's sample]** **[Color as selected by Architect from manufacturer's full range]** **<Insert color>**.
 2. Factory Prime Finish: Manufacturer's standard color.
 3. Stainless Steel Finish: **[ASTM A480/A480M No. 2B (bright, cold rolled)]** **[ASTM A480/A480M No. 4 (polished directional satin)]** **<Insert finish>**.
 4. Interior Curtain-Slat Facing: **[Match finish of exterior curtain-slat face]** **[Finish as indicated by manufacturer's designations]** **[Finish matching Architect's sample]** **[Finish as selected by Architect from manufacturer's full range]** **<Insert finish>**.

2.05 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.06 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
 2. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of 0.025 inch; and as required.
 3. Aluminum Door Curtain Slats: ASTM B209 sheet or ASTM B221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.
 4. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
 5. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
 6. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with **[minimum steel thickness of 0.010 inch]** **[and]** **[minimum aluminum thickness of 0.032 inch]**.

7. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of **[25] [75] [200]** and smoke-developed index of 450, according to ASTM E84 or UL 723.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, **[and a continuous bar for holding windlocks]**.
- C. Pass Door(s): Swinging-door and frame assembly constructed integrally with the coiling-door assembly **[and bearing the same fire rating]**. Comply with the accessibility standard of authorities having jurisdiction.
1. Door Frame and Integral Jamb Guide: Fabricate of angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading.
 2. Hinged Frame: Hinged pass door and frame that swings out of the way, as a unit, to allow use of the full coiling-door opening width. One jamb of the pass-door frame is hinged and the other jamb includes a guide for the lower, narrower part of the coiling-door curtain.
 3. Rigid Frame: Rigid pass door and frame that are built into the rigid, lower part of the door curtain and that raise with the curtain.
 4. Locking Hardware:
 - a. **[Lockset] [Exit Hardware]: [As specified in Section 08 71 00 "Door Hardware."]** **[As selected by Architect from manufacturer's full range.]** **<Insert requirement.>**
 - b. Lock Cylinders: As **[specified in Section 08 71 00 "Door Hardware"]** **[standard with manufacturer]** **[and keyed to building keying system].**
 - c. Keys: **[Two] [Three] <Insert number>** for each cylinder.
 5. Thresholds: Equip pass doors with integral thresholds that comply with the accessibility standard of authorities having jurisdiction.

2.07 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Galvanized Steel: Nominal 0.028-inch-thick, hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.
 2. Stainless Steel: 0.025-inch-thick, stainless steel sheet, Type 304, complying with ASTM A240/A240M or ASTM A666.
 3. Aluminum: 0.040-inch-thick aluminum sheet complying with ASTM B209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

4. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
 5. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.
- B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.08 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: As [specified in Section 08 71 00 "Door Hardware"] [standard with manufacturer] [and keyed to building keying system].
 2. Keys: **[Two] [Three] <Insert number>** for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.09 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.
- B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
1. At door head, use 1/8-inch-thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
 2. At door jambs, use replaceable, adjustable, continuous, [flexible, **1/8-inch**-thick seals of flexible vinyl, rubber, or neoprene] [nylon brushes] <Insert material>.
- C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
- D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
- E. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.
- F. Pole Hooks: Provide pole hooks and poles for doors more than 84 inches high.

- G. Automatic-Closing Device: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. **[Testing for manually operated doors allows resetting by opening the door without re-tensioning the counterbalance mechanism] [Release mechanism for motor-operated doors allows testing without mechanical release of the door.]** Automatic-closing device is to be designed for activation by the following:
1. Replaceable fusible links with temperature rise and melting point of **[165 deg F deg C]** **<Insert temperature>** interconnected and mounted on both sides of door opening.
 2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
 3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
 4. Building fire-detection, smoke-detection, and -alarm systems.

2.10 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, **[seamless] [or] [welded]** carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic-closing device operates.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.11 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed **[25 lbf] <Insert value>**.
- C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum **[25-lbf] [30-lbf] <Insert value>** force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

- D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than **[25-lbf]** **[30-lbf]** **<Insert value>** force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.12 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-rewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door Operator Location(s): Operator location indicated for each door.
1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
 2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
 3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
 4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
 5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.
- D. Motors: Reversible-type motor **[with controller (disconnect switch)]** for motor exposure indicated for each door assembly.
1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. **[For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.] [For fire-rated doors, activation delays closing.]**
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
 2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed **[25 lbf] [30 lbf] <Insert value>**.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

- L. Portable Radio-Control System: Consisting of **[one] [two] <Insert number>** of the following per door operator:
 - 1. Three-channel universal coaxial receiver to open, close, and stop door.
 - 2. Portable control device to open and stop door may be momentary-contact type; control to close door is to be sustained- or constant-pressure type.
 - 3. Remote-antenna mounting kit.

2.13 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.14 ALUMINUM FINISHES

- A. Mill Finish: Manufacturer's standard.
- B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.15 STEEL AND GALVANIZED-STEEL FINISHES

- A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.16 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M No. 4.

- C. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.
- C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.
- D. Fire-Rated Doors: Install according to NFPA 80.
- E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.
- F. Power-Operated Doors: Install **[automatic garage doors openers]** according to UL 325.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections and to furnish reports to Architect.
- B. Perform the following tests and inspections **[with the assistance of a factory-authorized service representative]**:
 - 1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
 - 2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in **[NFPA 80]** **[and]** **[NFPA 101]**.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.05 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
 - 1. Adjust exterior doors and components to be weather resistant.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide tight fit around entire perimeter.

3.06 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service includes **[three]** **[six]** **[nine]** **[12]** months' full maintenance by skilled employees of coiling-door Installer. Include **[monthly]** **[quarterly]** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.
 - 1. Perform maintenance, including emergency callback service, during normal working hours.
 - 2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

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SECTION 08 33 26
OVERHEAD COILING GRILLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Open-curtain overhead coiling grilles.
2. Closed-curtain overhead coiling grilles.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, angle-framing of grille opening, corner guards, and bollards.
2. [Section 099000 "Painting"] [and] [Section 099600 "High-Performance Coatings"] for finish painting of factory-primed grilles.
3. Section 111200 "Parking Control Equipment" for parking control equipment interlocked to overhead coiling grilles.

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling grille and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for curtain components, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction.
5. Show locations of controls, locking devices, and other accessories.
6. Include diagrams for power, signal, and control wiring.

- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Open-curtain grille with full-size components consisting of rods, spacers, and links as required to illustrate each assembly **[, including glazed inserts]**.
 - 2. Closed-curtain grille with full-size components consisting of ribs and infill as required to illustrate each assembly.
 - 3. Bottom bar **[with sensor edge]**.
 - 4. Guides.
 - 5. Mounting frame.
 - 6. Brackets.
 - 7. Hood.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For overhead coiling grilles to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- B. Accessibility Standard: Comply with applicable provisions in **[the USDOJ's "2010 ADA Standards for Accessible Design"] [the ABA standards of the Federal agency having jurisdiction] [and] [ICC A117.1] <Insert requirement>**.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of grilles that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **[Two] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain overhead coiling grilles from single source from single manufacturer.
1. Obtain operators and controls from overhead coiling-grille manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Overhead coiling grilles withstand the effects of earthquake motions determined according to **[ASCE/SEI 7] <Insert requirement>**.
1. Component Importance Factor: **[1.5] [1.0]**.

2.03 OPEN-CURTAIN GRILLE ASSEMBLY **<Insert drawing designation>**

- A. Open-Curtain Grille: Overhead coiling, **[countertop]** grille with a curtain having a network of horizontal rods that interconnect with vertical links.
- B. Operation Cycles: Grille components and operators capable of operating for not less than **[10,000] [20,000] [50,000] [100,000] [200,000] <Insert number>**. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.
1. Include tamperproof cycle counter.
- C. Grille Curtain Material: **[Aluminum] [Stainless steel] [Galvanized steel]**.
1. Rod Spacing: Approximately **[1-1/2 inches] [2 inches] [3 inches] <Insert dimension>** o.c.
 2. Link Spacing: Approximately **[3 inches] [6 inches] [9 inches] <Insert dimension>** apart in a **[straight in-line] [brick (staggered)] <Insert pattern>** pattern.
 3. Glazing Inserts: **[Manufacturer's standard] <Insert description>**.
 4. Spacers: **[Metal tubes matching curtain material] [PVC] <Insert description>**.
- D. Bottom Bar: Continuous **[tubular shape] [channel] [or] [doubled angles]**, fabricated from **[aluminum extrusion] [hot-dip galvanized steel] [or] [stainless steel]** and finished **[to match grille] <Insert requirement>**.
- E. Curtain Jamb Guides: **[Aluminum] [Stainless steel] [Galvanized steel]** with exposed finish **[matching curtain slats] <Insert requirement>**. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. **[Provide removable post(s) and jamb guides where indicated on Drawings.]**
- F. Hood: **[Match curtain material and finish] [Aluminum] [Stainless steel] [Galvanized steel]**.
1. Shape: **[Round] [Square] [As indicated on Drawings] <Insert shape>**.
 2. Mounting: **[Face of wall] [Between jambs] [On mounting frame] [As indicated on Drawings]**.

- G. Locking Devices: Equip grille with [slide bolt for padlock] [locking device assembly] [and] [chain lock keeper].
1. Locking Device Assembly: [Single-jamb side] [Cremona-type, both jamb sides] locking bars, operable from [inside with thumbturn] [outside with cylinder] [outside only, with cylinder] [inside and outside with cylinders] <Insert requirement>.
- H. Manual Grille Operator: [Push-up operation] [Chain-hoist operator] [Manufacturer's standard crank operator] [Awning-crank operator] [Wall-crank operator].
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.
- I. Electric Grille Operator:
1. Usage Classification: [Heavy duty, 25 or more cycles per hour and more than 90 cycles per day] [Standard duty, up to 25 cycles per hour and up to 90 cycles per day] [Medium duty, up to 12 cycles per hour and up to 50 cycles per day] [Light duty, up to 10 cycles per hour] <Insert classification>.
 2. Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; **[moving parts of operator enclosed or guarded if exposed and mounted at 8 feet or lower]**.
 4. Motor Exposure: [Interior] [Exterior, wet, and humid].
 5. Motor Electrical Characteristics:
 - a. Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - b. Voltage, Single Phase, 60 Hz: [115-V ac] [208-V ac] [230-V ac].
 - c. Voltage, Three Phase, 60 Hz: [208-V ac] [230-V ac] [460-V ac].
 6. Emergency Manual Operation: **[Push-up]** [Chain] [Crank] type.
 7. Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - a. Sensor Edge Bulb Color: [Black] [As selected by Architect from manufacturer's full range] <Insert color>.
 8. Control Station: [Interior mounted] [Exterior mounted] [Where indicated on Drawings] <Insert location>.
 9. Other Equipment: [Audible and visual signals] [Emergency-egress release] [Self-opening mechanism] <Insert device>.

- J. Curtain Accessories: Equip grille with **[astragal]** **[push/pull handles]** **[and]** **[pole hook]** **<Insert item>**.
- K. Grille Finish:
1. Aluminum Finish: **[Mill]** **[Clear anodized]** **[Light bronze anodized]** **[Medium bronze anodized]** **[Dark bronze anodized]** **[Black anodized]** **[Anodized color matching Architect's sample]** **[Anodized color as selected by Architect from full range of industry colors and color densities]** **<Insert color>**.
 2. Baked-Enamel or Powder-Coat Finish: **[Color as indicated by manufacturer's designations]** **[Color matching Architect's sample]** **[Color as selected by Architect from manufacturer's full range]** **<Insert color and gloss>**.
 3. Factory Prime Finish: Manufacturer's standard color.
 4. Stainless Steel Finish: **[No. 2B (bright, cold rolled)]** **[No. 4 (polished directional satin)]** **<Insert finish>**.
 5. PVC Spacers: **[Color as indicated by manufacturer's designations]** **[Color as selected by Architect from manufacturer's full range]** **<Insert color>**.

2.04 CLOSED-CURTAIN GRILLE ASSEMBLY **<Insert drawing designation>**

- A. Closed-Curtain Grille: Overhead coiling, **[countertop]** grille with a curtain having a series of horizontal ribs alternating with continuous horizontal infill panels secured by the ribs.
- B. Operation Cycles: Grille components and operators capable of operating for not less than **[10,000]** **[20,000]** **[50,000]** **[100,000]** **[200,000]** **<Insert number>**. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.
1. Include tamperproof cycle counter.
- C. Grille Curtain Material: Aluminum ribs with continuous inserts indicated.
1. Rib Spacing: Approximately **[3 inches]** **<Insert dimension>** o.c.
 2. Inserts: **[Glass panels]** **[Clear, transparent plastic panels]** **[Translucent plastic panels]** **[Solid aluminum panels]** **[Perforated aluminum panels]**.
- D. Bottom Bar: Continuous **[tubular shape]** **[channel]** **[or]** **[doubled angles]**, fabricated from **[aluminum extrusion]** **[hot-dip galvanized steel]** **[or]** **[stainless steel]** and finished **[to match grille]** **<Insert requirement>**.
- E. Curtain Jamb Guides: Aluminum with exposed finish **[matching curtain slats]** **<Insert requirement>**. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. **[Provide removable post(s) and jamb guides where indicated on Drawings.]**
- F. Hood: **[Match curtain material and finish]** **[Aluminum]** **[Stainless steel]** **[Galvanized steel]**.
1. Shape: **[Round]** **[Square]** **[As indicated on Drawings]** **<Insert shape>**.

2. Mounting: [Face of wall] [Between jambs] [On mounting frame] [As indicated on Drawings].
- G. Locking Devices: Equip grille with [slide bolt for padlock] [locking device assembly] [and] [chain lock keeper].
1. Locking Device Assembly: [Single-jamb side] [Cremone-type, both jamb sides] locking bars, operable from [inside with thumbturn] [outside with cylinder] [outside only, with cylinder] [inside and outside with cylinders] <Insert requirement>.
- H. Manual Grille Operator: [Push-up operation] [Chain-hoist operator] [Manufacturer's standard crank operator] [Awning-crank operator] [Wall-crank operator].
1. Provide operator with through-wall shaft operation.
 2. Provide operator with manufacturer's standard removable operating arm.
- I. Electric Grille Operator:
1. Usage Classification: [Heavy duty, 25 or more cycles per hour and more than 90 cycles per day] [Standard duty, up to 25 cycles per hour and up to 90 cycles per day] [Medium duty, up to 12 cycles per hour and up to 50 cycles per day] [Light duty, up to 10 cycles per hour] <Insert classification>.
 2. Operator Location: [Top of hood] [Front of hood] [Wall] [Bench] [Through wall] [As indicated on Drawings].
 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; **[moving parts of operator enclosed or guarded if exposed and mounted at 8 feet or lower]**.
 4. Motor Exposure: [Interior] [Exterior, wet, and humid].
 5. Motor Electrical Characteristics:
 - a. Horsepower: [1/2] [1] [2] [3] <Insert value> hp.
 - b. Voltage, Single Phase, 60 Hz: [115-V ac] [208-V ac] [230-V ac].
 - c. Voltage, Three Phase, 60 Hz: [208-V ac] [230-V ac] [460-V ac].
 6. Emergency Manual Operation: **[Push-up]** [Chain] [Crank] type.
 7. Obstruction-Detection Device: Automatic [photoelectric sensor] [electric sensor edge on bottom bar] [pneumatic sensor edge on bottom bar] [; self-monitoring type] <Insert type>.
 - a. Sensor Edge Bulb Color: [Black] [As selected by Architect from manufacturer's full range] <Insert color>.
 8. Control Station: [Interior mounted] [Exterior mounted] [Where indicated on Drawings] <Insert location>.

9. Other Equipment: [Audible and visual signals] [Emergency-egress release] [Self-opening mechanism] <Insert device>.

J. Grille Finish:

1. Aluminum Finish: [Mill] [Clear anodized] [Light bronze anodized] [Medium bronze anodized] [Dark bronze anodized] [Black anodized] [Anodized color matching Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] <Insert color>.
2. Baked-Enamel or Powder-Coat Finish: [Color as indicated by manufacturer's designations] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] <Insert color and gloss>.
3. Factory Prime Finish: Manufacturer's standard color.
4. Stainless Steel Finish: [No. 2B (bright, cold rolled)] [No. 4 (polished directional satin)] <Insert finish>.

2.05 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.06 GRILLE CURTAIN MATERIALS AND CONSTRUCTION

- A. Open-Curtain Grilles: Fabricate metal grille curtain as an open network of horizontal rods, spaced at regular intervals, that are interconnected with vertical links, which are formed and spaced as indicated and are free to rotate on the rods.
1. Aluminum Grille Curtain: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
 2. Stainless Steel Grille Curtain: ASTM A666 or ASTM A240/A240M, Type 300 series.
 3. Steel Grille Curtain: Hot-dip zinc coated (galvanized) complying with ASTM A123/A123M, or electrogalvanized complying with ASTM 653/A653M, and phosphatized before fabrication.
 4. Glazing Insert: Manufacturer's standard glazing of clear polycarbonate sheet secured by the curtain links.
- B. Closed-Curtain Grilles: Fabricate curtain as a series of horizontal double-C ribs, spaced at regular intervals, that alternate with continuous horizontal infill panels secured by the ribs.
1. Aluminum Horizontal Ribs: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
 2. Glass Panels: Uncoated, clear, heat-treated, fully tempered float glass; complying with ASTM C1048, Condition A, Type I, Class I, Quality q3, Kind FT; manufacturer's standard panel dimensions and thickness.
 3. Plastic Panels: Fire-retardant polycarbonate sheet manufactured by the extrusion process; UV resistant; manufacturer's standard panel dimensions and thickness.

4. Aluminum Panels: ASTM B209, alloy and temper standard with manufacturer for type of use and finish indicated; manufacturer's standard panel dimensions and thickness; finished to match ribs.
 - a. Perforations: [Manufacturer's standard pinholes] <Insert description>.
- C. Bottom Bar: Manufacturer's standard continuous shape unless otherwise indicated, finished to match grille.
 1. Astragal: Equip grille bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
 2. Provide motor-operated grilles with combination bottom astragal and sensor edge.
- D. Grille Curtain Jamb Guides: Manufacturer's standard shape having curtain groove with return lips or bars to retain curtain. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise; with removable stops on guides to prevent overtravel of curtain.
 1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.07 HOODS AND ACCESSORIES

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
 1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.
 2. Stainless Steel: 0.025-inch- thick, stainless steel sheet, Type 304, complying with ASTM A666 or ASTM A240/A240M.
 3. Aluminum: 0.040-inch- thick aluminum sheet, complying with ASTM B209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
- B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.
- C. Mounting Frame: Manufacturer's standard mounting frame designed to support grille; factory fabricated from ASTM A36/A36M structural-steel **[tubes] [or] [shapes]**, hot-dip galvanized per ASTM A123/A123M; fastened to floor and structure above grille; to be built into wall construction; and complete with anchors, connections, and fasteners.
- D. Push/Pull Handles: Equip push-up-operated or emergency-operated grille with lifting handles on each side of grille, finished to match grille.
- E. Pull-Down Strap: Provide pull-down straps for grilles more than 84 inches high.
- F. Pole Hooks: Provide pole hooks and poles for grilles more than 84 inches high.

2.08 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: As [specified in Section 087100 "Door Hardware"] [standard with manufacturer] [and keyed to building keying system].
 - 2. Keys: **[Two] [Three] <Insert number>** for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated grilles with safety interlock switch to disengage power supply when grille is locked.

2.09 COUNTERBALANCE MECHANISM

- A. General: Counterbalance grilles by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, **[seamless] [or] [welded]** carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of parts and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 MANUAL GRILLE OPERATORS

- A. General: Equip grille with manual grille operator by grille manufacturer.
- B. Push-up Grille Operation: Lift handles and pull rope for raising and lowering grille, with counterbalance mechanism designed so that required lift or pull for grille operation does not exceed **[25 lbf] <Insert value>**.
- C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum **[25-lbf] [30-lbf] <Insert value>** force for grille operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
- D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than **[25-lbf] [30-lbf] <Insert value>** force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.11 ELECTRIC GRILLE OPERATORS

- A. General: Electric grille operator assembly of size and capacity recommended and provided by grille manufacturer for grille and operation cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking grille, and accessories required for proper operation.
1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each grille.
- C. Grille Operator Location(s): Operator location indicated for each grille.
1. Top-of-Hood Mounted: Operator is mounted to the right or left grille head plate, with the operator on top of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
 2. Front-of-Hood Mounted: Operator is mounted to the right or left grille head plate, with the operator on coil side of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
 3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of grille and connected to grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
 4. Bench Mounted: Operator is mounted to the right or left grille head plate and connected to the grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
 5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of grille.
- D. Motors: Reversible-type motor [**with controller (disconnect switch)**] for motor exposure indicated for each grille assembly.
1. Electrical Characteristics: Minimum as indicated for each grille assembly. If not indicated, large enough to start, accelerate, and operate grille in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 2. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized grille with adjustable switches interlocked with motor controls and set to automatically stop grille at fully opened and fully closed positions.

- F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses downward grille travel.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in grille opening without contact between grille and obstruction.
 - a. Self-Monitoring Type: Designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, grille closes only with sustained or constant pressure on close button.
 2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire-configured device designed to interface with grille operator control circuit to detect damage to or disconnection of sensor edge.
 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type; NEMA ICS 6, Type 4 enclosure, key operated.
- H. Emergency Manual Operation: Equip electrically powered grille with capability for emergency manual operation. Design manual mechanism so required force for grille operation does not exceed **[25 lbf] [30 lbf] <Insert value>**.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.
- L. Emergency-Egress Release: Flush, wall-mounted handle mechanism, for accessibility-code-compliant egress feature, not dependent on electric power. The release allows an unlocked grille to partially open without affecting limit switches to permit passage, and it automatically resets motor drive on return of handle to original position.

- M. Self-Opening Mechanism: Automatic release mechanism triggered by **[smoke detector,] [emergency push-button station,]** fire alarm or power failure. When activated, the grille self-opens by means of a fail-safe operator to the fully open position without the need for power operation or battery backup systems. When the **[emergency push-button is reset, and the]** alarm is cleared and power is restored, the grille will operate normally.

2.12 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.13 ALUMINUM FINISHES

- A. Mill Finish: Manufacturer's standard.
- B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.14 STEEL AND GALVANIZED-STEEL FINISHES

- A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.15 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: No. 4.
- C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install overhead coiling grilles and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports, according to manufacturer's written instructions and as specified.
- B. Install overhead coiling grilles, hoods, controls, and operators at the mounting locations indicated for each grille.
- C. Accessibility: Install overhead coiling grilles, switches, and controls along accessible routes in compliance with the accessibility standard.
- D. Power-Operated Grilles: Install **[automatic garage grille openers]** according to UL 325.

3.03 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
 - 3. Test grille opening when activated by detector, fire-alarm system, emergency-egress release, or self-opening mechanism as required. Reset grille-opening mechanism after successful test.

3.04 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly, so that grilles operate easily, free of warp, twist, or distortion.
 - 1. Adjust exterior components to be weather resistant.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

3.05 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service is to include **[three] [six] [nine] [12]** months' full maintenance by skilled employees of coiling-grille Installer. Include **[monthly] [quarterly]** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper grille operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, 7-day-per-week, emergency callback service.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling grilles.

END OF SECTION

SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aluminum-framed entrance and storefront systems.

B. Related Requirements:

1. Section 01 43 39 "Mockups" for preconstruction laboratory mockup testing.
2. Section 08 11 16 "Interior Aluminum Doors and Frames" for interior aluminum framing.
3. Section 08 41 26 "All-Glass Entrances and Storefronts" for systems without aluminum support framing.

1.02 ALLOWANCES

- A. See Section 01 21 00 "Allowances" for description of allowances affecting items specified in this Section.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Aluminum-framed entrance and storefront systems.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories.

C. Shop Drawings:

1. Plans, elevations, sections, full-size details, and attachments to other work.
2. Details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
3. Full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrance and storefront systems, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.

- c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 4. Connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 5. Point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
 6. <Insert requirements>.
 7. Signed and sealed by the qualified professional engineer responsible for their preparation.
 - D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
 - E. Samples for Verification: Actual sample of finished products for each type of exposed finish.
 1. Size: **[Manufacturers' standard size]** <Insert size>.
 - F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 1. Joinery, including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
 - G. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
 - H. Delegated Design Submittals: For aluminum-framed entrances and storefront systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Energy Performance Certificates: For aluminum-framed entrance and storefront systems, accessories, and components, from manufacturer.
 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront system.
 - B. Product Test Reports: For aluminum-framed entrance and storefront systems, for tests performed by **[a qualified testing agency] [manufacturer and witnessed by a qualified testing agency]**.

- C. Preconstruction Test Reports: For aluminum-framed entrance and storefront systems.
 - 1. Testing Program: Developed specifically for Project.
 - 2. Test Reports: Prepared by a qualified preconstruction testing agency for each preconstruction test.
 - 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
 - D. Source Quality-Control Reports: For aluminum-framed entrance and storefront systems.
 - E. Field Quality-Control Reports: For aluminum-framed entrance and storefront systems.
 - F. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.
 - G. Qualification Statements:
 - 1. For Installer [and laboratory mockup preconstruction testing agency] [and field testing agency] [and egress door inspector].
 - H. Delegated Design Engineer Qualifications: For aluminum-framed entrance and storefront systems.
 - I. Sample Warranties: For aluminum-framed entrance and storefront systems.
- 1.06 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For aluminum-framed entrance and storefront systems.
 - B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront. Include ASTM C1401 recommendations for post-installation-phase quality-control program.
- 1.07 QUALITY ASSURANCE
- A. Installer Qualifications:
 - 1. Fabricator of products.
 - 2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 3. Authorized representative who is trained and approved by manufacturer.
 - 4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer [**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**].
 - B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [state] <Insert jurisdiction> where Project is located and who is experienced in providing engineering services of the type indicated.

- C. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025].
- D. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated **[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025]** and acceptable to Owner and Architect.
- E. Egress Door Inspector Qualifications:
 - 1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
 - 2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).
- F. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- G. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems that include structural glazing.

1.08 MOCKUPS

- A. Build mockups **[to verify selections made under Sample submittals] [to demonstrate aesthetic effects] [to set quality standards for materials and execution] [to set quality standards for fabrication and installation]**.
 - 1. Build mockup **[as indicated on Drawings]** <Insert mockup requirements>.
 - 2. Testing to be performed on mockups in accordance with requirements in "Field Quality Control" Article.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: **[Owner will engage] [Engage]** a qualified testing agency to perform preconstruction testing on laboratory mockups.
 - 1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
 - 2. Size and Configuration: As indicated on Drawings.

3. Notify Architect **[seven]** <Insert number> days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.
- B. Preconstruction Laboratory Mockup Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.
1. Test preconstruction laboratory mockups in accordance with requirements in "Performance Requirements" Article. Perform the following tests in the following order:
 - a. Structural, 50 Percent: ASTM E330/E330M at 50 percent of positive test load.
 - b. Air Leakage: ASTM E283.
 - c. Water Penetration under Static Pressure: ASTM E331.
 - d. Water Penetration under Dynamic Pressure: AAMA 501.1.
 - e. Thermal Cycling: AAMA 501.5. Repeat the following:
 - 1) Air Leakage: ASTM E283.
 - 2) Water Penetration under Static Pressure: ASTM E331.
 - f. Structural, 100 Percent: ASTM E330/E330M at 100 percent of positive and negative test loads. Repeat the following:
 - 1) Air Leakage: ASTM E283.
 - 2) Water Penetration under Static Pressure: ASTM E331.
 - 3) Water Penetration under Dynamic Pressure: AAMA 501.1.
 - g. Structural, 150 Percent: ASTM E330/E330M at 150 percent of positive and negative test loads.
- C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.
1. Compatibility: Test materials or components using ASTM C1087.
 2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
 3. Submit no fewer than **[eight]** <Insert number> pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.10 WARRANTY

- A. Special Warranty: **[Manufacturer agrees] [Installer agrees] [Manufacturer and Installer agree]** to repair or replace components of aluminum-framed entrance and storefront systems that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures, including **<Insert type of failure>**.
 - b. Faulty operation of **<Insert components>**.
 - c. Deterioration of metals **[, metal finishes,]** and other materials beyond normal **[weathering] [use]**.
 - d. **<Insert conditions relating to specified products>**.
 - e. **<Insert failure modes>**.
 2. Warranty Period: **[Two] [Five] [10] <Insert number>** years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: **[Five] [10] [20] <Insert number>** years from date of Substantial Completion.
- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: **[Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain all components of aluminum-framed entrance and storefront system, including framing **[spandrel panels] [venting windows]** and accessories, from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrance and storefront systems.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrance and storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrance and storefront systems to withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: **[As indicated on Drawings] <Insert loads>**.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to **[1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches] <Insert deflection limit>**.
 - 2. Deflection Parallel to Glazing Plane: Limited to **[amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch] <Insert deflection limit>**.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Limited to 2L/175 at unsupported cantilevers.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
 - 1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.

2. When tested at **[150]** <Insert number> percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **[0.2]** <Insert number> percent of span.
 3. Test Durations: As required by design wind velocity, but not less than **[10]** <Insert number> seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.]** <Insert value>.
- G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.]** <Insert value>.
 2. Maximum Water Leakage: [In accordance with AAMA 501.1] [No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation]. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Seismic Performance: Aluminum-framed entrance and storefront systems to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** <Insert requirement>.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement **[and 1.5 times the design displacement]**.
- I. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than **[0.41 Btu/sq. ft. x h x deg F] [0.45 Btu/sq. ft. x h x deg F] [0.57 Btu/sq. ft. x h x deg F] [0.69 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
 - b. Entrance Doors: U-factor of not more than **[0.68 Btu/sq. ft. x h x deg F] [0.77 Btu/sq. ft. x h x deg F] [0.83 Btu/sq. ft. x h x deg F] [1.10 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
 - c. Venting Windows: Whole window U-factor of not more than **[0.37 Btu/sq. ft. x h x deg F] [0.43 Btu/sq. ft. x h x deg F] [0.45 Btu/sq. ft. x h x deg F] [0.60 Btu/sq. ft. x h x deg F] [0.65 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than **[0.26] [0.35] [0.40] [0.45]** <Insert value> as determined in accordance with NFRC 200.
 - b. Entrance Doors: SHGC of not more than **[0.22] [0.25] [0.35] [0.40] [0.45]** <Insert value> as determined in accordance with NFRC 200.

- c. Venting Windows: Whole window SHGC of not more than **[0.22] [0.27] [0.30] [0.40] <Insert value>** as determined in accordance with NFRC 200.
 - 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than **[0.06 cfm/sq. ft.] <Insert value>** at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>** when tested in accordance with ASTM E283.
 - b. Entrance Doors: Air leakage of not more than **[1.0 cfm/sq. ft.] <Insert value>** at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - c. Venting Windows: Whole window air leakage of not more than **[0.3 cfm/sq. ft.] <Insert value>** at a static-air-pressure differential of **[6.24 lbf/sq. ft.] <Insert value>** when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than **[35] [55] [70] <Insert value>** as determined in accordance with AAMA 1503.
 - b. Entrance Doors: CRF of not less than **[57] [63] [68] <Insert value>** as determined in accordance with AAMA 1503.
 - c. Venting Windows: Whole window CRF of not less than **[45] [52] [55] <Insert value>** as determined in accordance with AAMA 1503.
- J. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.
 - 1. Outdoor-Indoor Transmission Class: Minimum **[26] [30] [34] <Insert number>**.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of **[180 deg F] <Insert temperature>**.
 - b. Low Exterior Ambient-Air Temperature: **[0 deg F] <Insert temperature>**.
 - c. Interior Ambient-Air Temperature: **[75 deg F] <Insert temperature>**.
- L. Structural-Sealant Joints:
 - 1. Designed to carry gravity loads of glazing.
- M. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrance and storefront systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant to occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.03 ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Exterior Framing Construction: [Thermally broken] [Thermally improved] [Nonthermal] <Insert description>.
 2. Interior Vestibule Framing Construction: **[Nonthermal]** <Insert description>.
 3. Glazing System: [Retained mechanically with gaskets on four sides] [Retained mechanically with gaskets on two sides and structural sealant on two sides].
 4. Glazing Plane: **[Front]** <Insert location>.
 5. Finish: [Clear anodic finish] [Color anodic finish] [Baked-enamel or powder-coat finish] [High-performance organic finish] [Superior-performance organic finish].
 6. Fabrication Method: Field-fabricated stick system.
 7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 8. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Insulated Spandrel Panels:
 1. Comply with Section 07 42 13.19 "Insulated Metal Wall Panels."
 2. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
 - a. Overall Panel Thickness: **[As indicated]** [1 inch] <Insert thickness>.
 - b. Exterior Skin: Aluminum.
 - 1) Thickness: [Manufacturer's standard for finish and texture indicated] <Insert thickness>.
 - 2) Finish: [Match framing system] <Insert finish>.
 - 3) Texture: [Smooth] [Embossed] <Insert texture>.
 - 4) Backing Sheet: **[1/8-inch-thick tempered hardboard]** **[0.157-inch-thick cement board]** **[0.125-inch-thick, corrugated, high-density polyethylene]** <Insert material>.
 - c. Interior Skin: Aluminum.

- 1) Thickness: [Manufacturer's standard for finish and texture indicated] <Insert thickness>.
 - 2) Finish: [Matching storefront framing] [Low-gloss, white baked enamel] [Mill finish] <Insert finish>.
 - 3) Texture: [Smooth] [Embossed] <Insert texture>.
 - 4) Backing Sheet: [1/8-inch-thick tempered hardboard] [0.157-inch-thick cement board] [1/2-inch-thick gypsum board with proprietary fire-resistance-rated core] [0.125-inch-thick, corrugated, high-density polyethylene] <Insert material>.
- d. Thermal Insulation Core: Manufacturer's standard [rigid, closed-cell, polyisocyanurate board] [extruded-polystyrene board] [expanded-perlite, mineral-insulation board] <Insert insulation>.
- e. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- 1) Flame-Spread Index: [25] <Insert value> or less.
 - 2) Smoke-Developed Index: [50] [450] <Insert value> or less.
- E. Venting Windows:
1. As specified in Section 08 51 00 "Metal Windows."
 2. Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:
 - a. Window Type: [Awning] [Casement] [As indicated on Drawings] <Insert type>.
 - b. Minimum Performance Class: [CW] [AW] <Insert class>.
 - c. Minimum Performance Grade: [30] [40] [60] [70] [80] [90] [As indicated on Drawings] <Insert number>.
 - d. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
 - 1) Cam handle locking system.
 - 2) Multi-point locking system.
 - 3) Pole-operated, cam handle locking system, where rail is more than 72 inches above floor.
 - 4) Rotary operator.
 - 5) Steel or bronze operating arms.
 - 6) Limit Devices: [Concealed friction adjustor and adjustable stay bar] <Insert type> limit devices designed to restrict sash opening.

- (a) Limit clear opening to **[4 inches]** <Insert dimension> for ventilation; with custodial key release.
 - e. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
 - f. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
 - 1) Aluminum Wire Fabric: 18-by-18, 0.0445-inch-by-0.0445-inch; 18-by-16, 0.0445-inch-by-0.0515-inch; or 18-by-14, 0.0445-inch-by-0.0624-inch mesh of 0.013-inch-diameter, coated aluminum wire.
 - 2) Glass-Fiber Mesh Fabric: 18-by-16 0.0445-inch-by-0.0515-inch or 18-by-14 0.0445-inch-by-0.0624-inch mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
 - 3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.
 - g. Glazing: [Same as adjacent aluminum-framed entrances and storefront glazing] <Insert glazing>.
 - h. Finish: [Match adjacent aluminum-framed entrances and storefront finish] <Insert finish>.
- F. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
- 1. Door Construction: **[1-3/4-inch overall thickness, with minimum 0.125-inch-] [2-inch overall thickness, with minimum 0.188-inch-] [2- to 2-1/4-inch overall thickness, with minimum 0.125-inch-]** thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: [High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior] <Insert description>.
 - 2. Door Design: [As indicated] [Narrow stile; **2-1/8-inch** nominal width] [Medium stile; **3-1/2-inch** nominal width] [Wide stile; **5-inch** nominal width] <Insert description>.
 - 3. Glazing Stops and Gaskets: **[Beveled] [Square] <Insert description>**, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 - 4. Finish: Match adjacent storefront framing finish.

2.04 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

- B. General: Provide entrance door hardware and [entrance door hardware sets indicated in door and frame schedule] [entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article] for each entrance door, to comply with requirements in this Section.
1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and [named manufacturers' products] [products equivalent in function and comparable in quality to named products] [products complying with BHMA standard referenced].
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 3. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion [**and not more than 15 lbf to open the door to its minimum required width**].
 - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Pivot Hinges: BHMA A156.4, Grade 1.
1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.
- E. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
1. Nonremovable Pins: Provide setscrew in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
 2. Exterior Hinges: [Stainless steel, with stainless steel pin] [Nonferrous] <Insert material>.
 3. Quantities:
 - a. For doors up to [87 inches] <Insert dimension> high, provide three hinges per leaf.
 - b. For doors more than [87 and up to 120 inches] <Insert dimensions> high, provide four hinges per leaf.
- F. Continuous-Gear Hinges: BHMA A156.26.
- G. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
- H. Manual Flush Bolts: BHMA A156.16, Grade 1.
- I. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.

- J. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.
 - K. Cylinders:
 - 1. As specified in Section 08 71 00 "Door Hardware."
 - 2. BHMA A156.5, Grade 1.
 - a. Keying: **[No master] [Master]** key system. Permanently inscribe each key with a visual key control number and include notation **["DO NOT DUPLICATE"] [to be furnished by Owner]**.
 - L. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
 - M. Operating Trim: BHMA A156.6.
 - N. Removable Mullions: BHMA A156.3 extruded aluminum.
 - 1. When used with panic exit devices, provide **[keyed]** removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305. Use only mullions that have been tested with exit devices to be used.
 - O. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
 - P. Concealed Overhead Holders and Stops: BHMA A156.8, Grade 1.
 - Q. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
 - R. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
 - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
 - S. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
 - T. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.
 - U. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.
- 2.05 GLAZING
- A. Glazing: Comply with Section 08 80 00 "Glazing."

- B. Glazing Gaskets: [Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.] [Comply with Section 08 80 00 "Glazing."]
- C. Glazing Sealants: [As recommended by manufacturer.] [Comply with Section 08 80 00 "Glazing."]
- D. Structural Glazing Sealants: ASTM C1184 chemically curing silicone formulation that is compatible with system components with which it comes in contact; specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.
 - 1. Color: [Black] [Gray] [As selected by Architect from manufacturer's full range of colors] <Insert color>.
- E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
 - 1. Color: Match structural sealant.

2.06 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.07 ACCESSORIES

- A. Automatic Door Operators: Section 08 42 29.23 "Sliding Automatic Entrances."
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads [, finished to match framing system] [, fabricated from 300 series stainless steel].

- C. Anchors: Three-way adjustable anchors with minimum adjustment of **[1 inch] <Insert dimension>** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- D. Concealed Flashing: **[Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials] [Dead-soft, 0.018-inch-thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer].**
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC filler.

2.08 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from **[exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels].**
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Storefront Framing: Fabricate components for assembly using **[shear-block system] [screw-spline system] [head-and-sill-receptor system with shear blocks at intermediate horizontal members] <Insert system>**.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.

2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- J. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.09 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- B. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
 1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Champagne] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- 2.10 SOURCE QUALITY CONTROL
- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.
- K. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- L. Install entrance doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- M. Install glazing as specified in Section 08 80 00 "Glazing."
- N. Install structural glazing as follows:
1. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 2. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
 3. Set glazing with proper orientation so that coatings face exterior or interior as specified.
 4. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.
 5. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer and framing manufacturer's written instructions and in compliance with local codes.
 6. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
 7. Allow structural sealant to cure in accordance with manufacturer's written instructions.
 8. Clean and protect glass as indicated in Section 08 80 00 "Glazing."
 9. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.
 10. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.03 ERECTION TOLERANCES

- A. Install aluminum-framed entrance and storefront systems to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests.
- B. Tests: Perform the following tests on **[representative areas of aluminum-framed entrance and storefront systems] [mockups]** <Insert requirements>.
 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration.
 - a. Perform a minimum of **[two] [three]** <Insert number> tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to **[10, 35, and 70 percent completion]** <Insert requirements>.
 2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - a. Perform a minimum of **[two] [three]** <Insert number> tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to **[10, 35, and 70 percent completion]** <Insert requirements>.
 3. Water Penetration: ASTM E1105 at a minimum **[uniform] [and] [cyclic]** static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and to not evidence water penetration.
 4. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 - a. Test a minimum of **[two] [four] [six]** <Insert number> areas on each building facade.
 - b. Repair installation areas damaged by testing.

- C. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections.
 - D. Inspections:
 - 1. Egress Door Inspections: Inspect each aluminum-framed entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
 - E. Aluminum-framed entrance and storefront systems will be considered defective if they do not pass tests and inspections.
 - F. Prepare test and inspection reports.
- 3.05 MAINTENANCE SERVICE
- A. Entrance Door Hardware Maintenance:
 - 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
 - 2. Initial Maintenance Service: Beginning at Substantial Completion, provide **[six] <Insert number>** months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.
- 3.06 ENTRANCE DOOR HARDWARE SETS
- A. **<Insert schedule>**.

END OF SECTION

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SECTION 08 41 26

ALL-GLASS ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior all-glass entrance and storefront systems.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for overhead-steel support for all-glass systems.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Exterior all-glass entrance and storefront systems.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.

C. Shop Drawings: For exterior all-glass entrance and storefront systems.

1. Plans, elevations, and sections.
2. Details of fittings and glazing, including isometric drawings of fittings.
3. Door hardware locations, mounting heights, and installation requirements.
4. <Insert requirements>.
5. Signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of fitting, accessory fitting, glass, and door hardware.

E. Samples for Verification: Actual sample of finished products for each type of fitting, accessory fitting, glass showing exposed edge finish, and door hardware.

1. Size: [Manufacturers' standard size] <Insert size>.

F. Fabrication Sample: **[Patch fitting at sill on pivot side only]** **[Continuous rail fitting at bottom]** <Insert requirements>, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery.

2. Anchorage.
 3. Glazing[with butt glazing].
- G. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with all-glass entrance-system components, assemblies, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- H. Delegated Design Submittals: For exterior all-glass entrance and storefront systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Product Test Reports: For each exterior all-glass entrance and storefront system, for tests performed by **[a qualified testing agency] [manufacturer and witnessed by a qualified testing agency]**.
- B. Field Quality-Control Reports: For exterior all-glass entrance and storefront systems.
- C. Qualification Statements:
1. For Installer[and testing agency][and egress door inspector].
- D. Delegated Design Engineer Qualifications: For exterior all-glass entrance and storefront systems.
- E. Sample Warranties: For exterior all-glass entrance and storefront systems.
- 1.05 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For exterior all-glass entrance and storefront systems.
- 1.06 QUALITY ASSURANCE
- A. Installer Qualifications:
1. Fabricator of products.
 2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
 3. Authorized representative who is trained and approved by manufacturer.
 4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer[**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**].
- B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in **[state] <Insert jurisdiction>** where Project is located and who is experienced in providing engineering services of the type indicated.
- C. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025].

D. Egress Door Inspector Qualifications:

1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.07 MOCKUPS

A. Build mockups [to verify selections made under Sample submittals] [to demonstrate aesthetic effects] [to set quality standards for materials and execution] [to set quality standards for fabrication and installation].

1. Build mockup [as indicated on Drawings] <Insert mockup requirements>.
2. Testing must be performed on mockups in accordance with requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 WARRANTY

A. Special Warranty: **[Manufacturer agrees] [Installer agrees] [Manufacturer and Installer agree]** to repair or replace components of exterior all-glass entrance and storefront systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection[, **air leakage, or water penetration**].
 - b. Faulty operation of **<Insert components>**.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal **[weathering] [use]**.
 - d. **<Insert conditions relating to specified products>**.
 - e. **<Insert failure modes>**.
2. Warranty Period: **[Two] <Insert number>** years from date of Substantial Completion.

- a. Concealed Floor Closers: **[Five] [10] [25]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain all components of exterior all-glass entrance and storefront systems, including framing and accessories, from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design exterior all-glass entrance and storefront systems.
- B. General Performance: Comply with performance requirements specified, as determined by testing of exterior all-glass entrance and storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- C. Structural Loads:
 1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: [As indicated on Drawings] <Insert loads>.
 3. Deflection Limits: Deflection normal to glazing plane is limited to **[1 inch]** [1/175 of clear span or **3/4 inch**, whichever is smaller] <Insert deflection limit>.
- D. Seismic Performance: All-glass entrance and storefront systems to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** <Insert requirement>.
- E. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.

2.03 EXTERIOR ALL-GLASS ENTRANCE AND STOREFRONT SYSTEMS

- A. Fitting Configuration:
 1. Manual-Swinging, All-Glass Entrance Doors: [Patch fittings at head and sill on pivot side only (A-Style)] [Patch fittings at head and sill on pivot side, and for lock at sill of swing side (F-Style)] [Patch fitting at top and continuous rail fitting at bottom (BP-Style)] [Continuous rail fitting at top and bottom (P-Style)] <Insert fitting configuration>.
 2. All-Glass Storefronts: [Recessed glazing channel at top and continuous rail fitting at bottom] [Recessed glazing channel at top and bottom] [Continuous rail fitting at top and bottom] <Insert fitting configuration>.
- B. Fitting Material: [Aluminum] [Bronze-clad aluminum] [Brass-clad aluminum] [Stainless steel clad aluminum].
- C. Rail Fittings:

1. Height:
 - a. Top Rail: **[3-1/2 inches]** [As indicated] <Insert dimension>.
 - b. Bottom Rail: **[3-1/2 inches]** [**10 inches]** [As indicated] <Insert dimension>.
 2. Profile: [Tapered] [Tapered flat] [Tapered at 60 degrees minimum from horizontal] [Square] [Curved] [As indicated] <Insert profile>.
 3. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
- D. Accessory Fittings:
1. Overhead doorstep.
 2. Center-housing lock.
 3. U-channel.
 4. Glass-support-fin brackets.
- E. Anchors and Fastenings: Concealed.
- F. Weather Stripping: Pile type; replaceable without removing all-glass entrance doors from pivots.
- G. Materials:
1. Aluminum: ASTM B221, with strength and durability characteristics of not less than Alloy 6063-T5.
 - a. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 - b. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
 - c. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
 2. Bronze Cladding: ASTM B36/B36M, alloy [as standard with manufacturer] <Insert requirements>.
 - a. Finish: [Polished M21-O6x] [Satin M31-M34-O6x] [Statuary M31-C5] [Match Architect's sample] [As selected by Architect from full range of industry finishes] <Insert finish>.
 3. Brass Cladding: ASTM B36/B36M, alloy [as standard with manufacturer] <Insert requirements>.
 - a. Finish: [Polished M21-O6x] [Satin M31-M34-O6x] [As selected by Architect from full range of industry finishes] <Insert finish>.
 4. Stainless Steel Cladding: ASTM A240/A240M or ASTM A666, Type 304.
 - a. Finish: [ASTM A480/480M No. 4 directional satin finish] [ASTM A480/480M No. 8 mirrorlike reflective, nondirectional polish] <Insert finish>.

2.04 GLASS

- A. Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Quality-Q3, tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.
1. Class 1: Clear monolithic.
 - a. Thickness: [**10**] [**12**] [**16**] [**19**] mm.
 - b. Locations: [As indicated] <Insert locations>.
 2. Class 2: Tinted monolithic.
 - a. Color: [Gray] [Bronze] <Insert color>.
 - b. Thickness: [**10**] [**12**] mm.
 - c. Locations: [As indicated] <Insert locations>.
 - d. Visible Light Transmittance: <Insert number> percent minimum.
 - e. Solar Heat-Gain Coefficient: <Insert value> maximum.
 - f. Outdoor Visible Reflectance: <Insert number> percent maximum.
 3. Exposed Edges: Machine ground and flat polished.
 4. Butt Edges: Flat ground.
 5. Corner Edges: Lap-joint corners with exposed edges polished.

2.05 ENTRANCE DOOR HARDWARE

- A. General: Entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of fittings.
- B. Concealed Floor Closers and Top Pivots: Center hung; ANSI/BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation.
1. Swing: [**Single**] [**Double**] acting.
 - a. Positive Dead Stop: Coordinated with hold-open angle if any, or at angle selected.
 2. Hold Open: [Automatic, at angle selected] [Selective] [None].
 3. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion[**and not more than 15 lbf to open the door to its minimum required width**].
- C. Concealed Overhead Holder: ANSI/BHMA A156.8, Grade 1, with dead-stop setting coordinated with concealed floor closer.
- D. Push-Pull Set: [As selected from manufacturer's full range] [As indicated] <Insert description>.

- E. Single-Door and Active-Leaf Locksets: [Center-housing deadbolt with pulls] [Center-housing combination deadbolt and latchbolt with lever handles] [Bottom-fitting or bottom-rail deadbolt] <Insert description>.
 - 1. Deadbolt operated by key outside and [key] [thumbturn] inside.
 - F. Inactive-Leaf Locksets: Bottom-fitting or bottom-rail deadbolt.
 - 1. Deadbolt operated by key outside and [key] [thumbturn] inside.
 - G. Cylinders: [As specified in Section 08 71 00 "Door Hardware."] [As specified in Section 08 71 11 "Door Hardware (Descriptive Specification)."] [Six-pin cylinder, ANSI/BHMA A156.5, Grade 1.] <Insert requirements.>
 - H. Exit Devices: UL 305.
 - 1. Function: Operation by push-pull when [inside operator is locked down (dogged)] [inside operator is locked down (dogged); outside operation by key].
 - 2. Latching: At [threshold or floor plate] [door head] [threshold or floor plate and door head].
 - 3. Style: [Exposed vertical rod] [Concealed vertical rod in housing style indicated] <Insert style>.
 - 4. Provide exit devices on both leaves of pairs of doors.
 - I. Threshold: Not more than 1/2 inch high.
- 2.06 BUTT-GLAZING SEALANTS
- A. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 25, for Uses NT, G, and A.
- 2.07 FABRICATION
- A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
 - 1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
 - B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF EXTERIOR ALL-GLASS ENTRANCE AND STOREFRONT SYSTEMS

- A. Install all-glass entrance and storefront systems and associated components according to manufacturer's written instructions.

- B. Set units level, plumb, and true to line, with uniform joints.
- C. Maintain uniform clearances between adjacent components.
- D. Lubricate hardware and other moving parts in accordance with manufacturer's written instructions.
- E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
- F. Install butt-joint sealants according to manufacturer's written instructions and as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests.
- B. Tests: Perform the following tests on [representative areas of exterior all-glass storefront systems] [mockups] <Insert requirements>.
 - 1. Water-Spray Test: After completion of all-glass storefront installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test storefront for water leaks in accordance with AAMA 501.2.
 - a. Perform test for total areas [as designated by Architect] <Insert description>.
- C. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections.
- D. Inspections:
 - 1. Egress Door Inspections: Inspect each exterior all-glass entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
- E. Exterior all-glass entrance and storefront systems will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.04 ADJUSTING AND CLEANING

- A. Adjust all-glass entrance doors and hardware to function smoothly and fit tightly at contact points and weather stripping.
 - 1. For exterior all-glass entrance doors accessible to people with disabilities, adjust closers to provide a three-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.
- B. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION

SECTION 08 42 29.23

SLIDING AUTOMATIC ENTRANCES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Sliding automatic entrances.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for **[installing recessed metal frames for control mats in concrete] [and] [forming recesses in concrete for recessed thresholds]**.
 - 2. Section 08 71 13 "Automatic Swing Door Operators" for automatic door operators furnished separately from doors and frames.

1.02 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- D. For automatic door terminology, refer to BHMA A156.10 for definitions of terms.

1.03 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for **[recessed sliding tracks] [and] [recessed control mats]** that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.
- C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.
- D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies **[and access-control system] [and remote activation devices] [and remote monitoring systems]**.
- E. System Integration: Integrate sliding automatic entrances with other systems as required for a complete working installation.
 - 1. Provide electrical interface control capability for activation of sliding automatic entrances by security access system on doors with electric locking.
 - 2. Provide electrical interface to deactivate door operators on activation of fire alarm system.

3. Provide electrical interface to allow for remote monitoring of automatic entrance door panel status.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.05 ACTION SUBMITTALS

- A. Product Data: Sliding automatic entrances.
- B. Product Data Submittals: For each product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
- D. Shop Drawings: For sliding automatic entrances.
 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
 2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
 4. Indicate locations of activation and safety devices.
 5. Include hardware schedule and indicate hardware types, functions, quantities, and locations.
- E. Samples for Initial Selection: For units with factory-applied **[color]** **[and]** **[metal-clad]** finishes.
 1. Include Samples of hardware and accessories involving color or finish selection.
- F. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- G. Delegated Design Submittals: For automatic entrances.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer]** **[manufacturer]** **[Certified Inspector]**.
- B. Product Certificates: For each type of automatic entrance. **[Include emergency-exit features of automatic entrances serving as a required means of egress.]**
- C. Product Test Reports: For each type of automatic entrance, for tests performed by a qualified testing agency.
- D. Field quality-control reports.
- E. Sample Warranties: For manufacturer's special warranties.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems to include in operation and maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer with Company Certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project **[and who employs a Certified Inspector]**.
 - 1. Maintenance Proximity: Not more than **[two]** <Insert number> hours' normal travel time from Installer's place of business to Project site.
- C. Certified Inspector Qualifications: Certified by AAADM.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of operators, controls, and hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: **[Two]** <Insert number> years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: **[Five] [10] [20]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain sliding **[folding] [and] [swinging]** automatic entrances from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Power-Operated Door Standard: BHMA A156.10.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design automatic entrances.
- D. Structural Performance: Automatic entrances to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with **[ASCE/SEI 7]** <Insert requirement>.
 - 1. Seismic Loads: <Insert loads>.
 - 2. Wind Loads: <Insert loads>.
- E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone **[1] [2] [3] [4]** for **[basic] [enhanced]** protection.
 - 1. Large-Missile Test: For glazing located within **[30 feet]** <Insert dimension> of grade.
 - 2. Small-Missile Test: For glazing located between 30 feet and **[60 feet]** <Insert dimension> above grade.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.
- G. Operating Temperature Range: Automatic entrances to operate within **[minus 20 to plus 122 deg F]** <Insert temperature range>.
- H. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 - 1. Thermal Transmittance (U-Factor):
 - a. Entrance Doors: U-factor of not more than **[0.63 Btu/sq. ft. x h x deg F] [0.68 Btu/sq. ft. x h x deg F] [0.77 Btu/sq. ft. x h x deg F] [0.83 Btu/sq. ft. x h x deg F] [0.90 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
 - 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Entrance Doors: SHGC of not more than **[0.21] [0.25] [0.35] [0.40] [0.45]** <Insert value> as determined in accordance with NFRC 200.
 - 3. Air Leakage:
 - a. Power-Operated Sliding Doors: Air leakage of not more than **[1.0 cfm/sq. ft.]** <Insert value> at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - 4. Condensation Resistance Factor (CRF):
 - a. Entrance Doors: CRF of not less than **[57] [63] [68]** <Insert value> as determined in accordance with AAMA 1503.
- I. Opening Force:

1. Power-Operated Doors: Not more than 50 lbf required to manually set door in motion if power fails, and not more than 15 lbf required to open door to minimum required width.
2. Breakaway Device for Power-Operated Doors: Not more than 50 lbf required for a breakaway door or panel to open.

J. Entrapment-Prevention Force:

1. Power-Operated Sliding Doors: Not more than 30 lbf required to prevent stopped door from closing.

2.03 SLIDING AUTOMATIC ENTRANCES

A. General: Provide manufacturer's standard automatic entrances, including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.

B. Sliding, Power-Operated Automatic Entrances **<Insert drawing designation>**:

1. Configuration, Single-Sliding: Single-sliding door with one sliding leaf **[, transom,]** **[and]** **[pocketed]** sidelite.
 - a. Traffic Pattern: **[One]** **[Two]** way.
 - b. Emergency Breakaway Capability: **[As indicated on Drawings]** **[Sliding leaf only]** **[Sliding leaf and sidelite]**.
 - c. Mounting: **[Between jambs]** **[Surface]**.
2. Configuration, Biparting-Sliding: Biparting-sliding doors with two sliding leaves **[, transom,]** **[and]** **[pocketed]** sidelites on each side.
 - a. Traffic Pattern: **[One]** **[Two]** way.
 - b. Emergency Breakaway Capability: **[As indicated on Drawings]** **[Sliding leaves only]** **[Sliding leaves and sidelites]**.
 - c. Mounting: **[Between jambs]** **[Surface]**.
3. Configuration, Telescoping: **[Single-telescoping-sliding door with two]** **[Biparting-telescoping-sliding doors with four]** sliding leaves **[, transom,]** and sidelite(s).
 - a. Traffic Pattern: **[One]** **[Two]** way.
 - b. Emergency Breakaway Capability: **[As indicated on Drawings]** **[Center leaves only]** **[All leaves]**.
 - c. Mounting: Between jambs.
4. Operator Features:
 - a. Power opening and closing.
 - b. Drive System: **[Chain]** **[or]** **[belt]**.
 - c. Adjustable opening and closing speeds.

- d. Adjustable hold-open time between zero and 30 seconds.
 - e. Obstruction recycle.
 - f. On-off/hold-open switch to control electric power to operator **[, key operated]**.
 - g. <Insert features required>.
5. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: Carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
- a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
6. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless steel, ball-bearing-center roller wheels.
- a. Configuration, Threshold: Saddle-type threshold across door opening and **[surface-mounted] [recessed]** guide-track system at sidelites.
 - b. Configuration, No Threshold: No threshold across door opening and **[surface-mounted] [recessed]** guide-track system at sidelites.
7. Controls: Activation and safety devices **[as indicated on Drawings and]** in accordance with BHMA standards.
- a. Activation Device, Motion Sensor: Mounted on each side of door header to detect pedestrians in activating zone and to open door.
 - b. Activation Device, Control Mat: Installed on ingress side of door to detect pedestrians in activating zone and to open door.
 - c. Activation Device, Switch: **[Push-plate switch] [Push-button switch] [Key switch] [Touchless switch] [on each side of door]** to activate door operator.
 - d. Safety Device, Photoelectric Beams: Two photoelectric beams mounted in sidelite jambs on each side of door to detect pedestrians in presence zone and to prevent door from closing.
 - e. Safety Device, Presence Sensor Under Door Header and Photoelectric Beams: Presence sensor mounted to underside of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing.
 - f. Safety Device, Presence Sensor on Sides of Door Header and Photoelectric Beams: Presence sensor mounted on each side of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing.
 - g. Safety Device, Control Mat(s): Control mat(s) installed on egress side of door to detect pedestrians in presence and safety zones and to prevent door from closing.

- h. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening.
 - i. Opening-Width Control: Two-position switch that in the normal position allows sliding doors to travel to full opening width and in the alternate position reduces opening to a selected partial opening width.
8. Finish: Finish framing, door(s), and header with [Class I, clear anodic finish] [Class II, clear anodic finish] [Class I, color anodic finish] [Class II, color anodic finish] [baked-enamel or powder-coat finish] [high-performance organic finish (two-coat fluoropolymer)] [high-performance organic finish (three-coat fluoropolymer)] [finish matching adjacent curtain wall] [finish matching adjacent storefront].
- a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
9. Metal Cladding and Finish: Clad framing, door(s), and header with [No. 4 directional-satin-finish stainless steel sheet] [No. 8 mirrorlike reflective, nondirectional-polish-finish stainless steel sheet] [satin-brass sheet] [polished-brass sheet] [satin-bronze sheet] [polished-bronze sheet] [metal sheet in finish matching Architect's sample] [metal sheet in finish as selected by Architect from manufacturer's full range] [metal sheet in finish matching adjacent storefront] <Insert finish>.

2.04 ENTRANCE COMPONENTS

- A. Framing Members: Extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
 - 1. Nominal Size: [As indicated on Drawings] [**1-3/4 by 4-1/2 inches**] [**1-3/4 by 6 inches**] <Insert dimensions>.
 - 2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.
- B. Stile and Rail Doors: 1-3/4-inch-thick, glazed doors with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.
 - 1. Glazing Stops and Gaskets: [**Beveled**] [**Square**], snap-on, extruded-aluminum stops and preformed gaskets.
 - 2. Stile Design: [As indicated on Drawings] [Thin stile, less than **1-3/4-inch** nominal width] [**Narrow stile, 2-1/8-inch** nominal width] [Medium stile, **3-1/2-inch** nominal width] [Wide stile, more than **4-inch** nominal width].
 - 3. Rail Design: [As indicated on Drawings] [**5-inch** nominal height] [**6-1/2-inch** nominal height] [**10-inch** nominal height].
 - 4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.
- C. All-Glass Sliding Doors: Fabricated from 1/2-inch-thick tempered glass, with polished vertical edges and minimum 0.125-inch-thick, extruded-aluminum top and bottom rails.
 - 1. Rail Design: [**3-1/2-inch**] [**5-inch**] nominal height.
- D. Sidelite(s): 1-3/4-inch-deep sidelite(s) with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design.

1. Glazing Stops and Gaskets: [Same materials and design as for stile and rail door] [Beveled, snap-on, extruded-aluminum stops and preformed gaskets] [Square, snap-on, extruded-aluminum stops and preformed gaskets].
 2. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.
- E. Transom: 1-3/4-inch-deep transom with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design.
1. Glazing Stops and Gaskets: [Same materials and design as for stile and rail door] [Beveled, snap-on, extruded-aluminum stops and preformed gaskets] [Square, snap-on, extruded-aluminum stops and preformed gaskets].
- F. Headers: Fabricated from minimum 0.125-inch-thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
1. Mounting: [Surface mounted] [Concealed, with one side of header flush with framing].
 2. Capacity: Capable of supporting doors of up to **175 lb per leaf over spans of up to 14 feet** <Insert load and span required> without intermediate supports.
 - a. Provide sag rods for spans exceeding 14 feet.
- G. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- H. Signage: As required by cited BHMA standard.
1. Application Process: [Decals] [Silk-screened] [Door manufacturer's standard process] <Insert requirement>.
 2. Provide sign materials with instructions for field application after glazing is installed.

2.05 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extrusions: ASTM B221.
 2. Sheet: ASTM B209.
- B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.
- C. Stainless Steel Bars: ASTM A276/A276M or ASTM A666, **[type 304] [type 316]** <Insert type>.
- D. Stainless Steel Tubing: ASTM A554, [Grade MT 304] [Grade MT 316] <Insert grade>.
- E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, **[type 304] [type 316]** <Insert type>, stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.
- F. Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in entrance manufacturer's standard thickness.

- G. Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in entrance manufacturer's standard thickness.
- H. Expanded Aluminum Mesh: **[Expanded] [Expanded and flattened]** aluminum sheet in accordance with the geometry of ASTM F1267.
- I. Polycarbonate Sheet: ASTM C1349, Appendix X1, type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.
- J. Glazing: As specified in **[Section 08 80 00 "Glazing."]** **[Section 08 88 53 "Security Glazing."]**
- K. Sealants and Joint Fillers: As specified in Section 07 92 00 "Joint Sealants."
- L. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C1107/C1107M; of consistency suitable for application.
- M. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- N. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.06 DOOR OPERATORS AND CONTROLS

- A. General: Provide operators and controls, which include activation and safety devices, in accordance with BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
- B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.
 - 1. Door Operator Performance: Door operators to open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
 - 2. Electromechanical Operators: Concealed, self-contained, overhead units powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; complying with UL 325; and with manual operation with power off.
- C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by their plastic housings; adjustable to provide detection-field sizes and functions required by BHMA A156.10.
 - 1. Provide capability for switching between bi- and unidirectional detection.
 - 2. For one-way traffic, sensor on egress side to not be active when doors are fully closed.
- D. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection-field sizes and functions required by BHMA A156.10. Sensors remain active at all times.
- E. Photoelectric Beams: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams to not be active when doors are fully closed.

- F. Control Mats: 1/2-inch-thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements of BHMA A156.10.
1. Frame: [Recessed to fit flush with floor, with concealed anchors] [Surface mounted, with tapered safety edge].
 2. Size: As indicated, but no smaller than required by BHMA A156.10, including Appendix A.
 3. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].
- G. Push-Plate Switch: Momentary-contact door-control switch with flat push-plate actuator [**with contrasting-colored, engraved message**].
1. Configuration, Round: Round push plate with 4-by-4-inch junction box.
 - a. Mounting: [As indicated on Drawings] [Recess mounted, semiflush in wall] [Surface mounted on wall].
 2. Configuration, Square: Square push plate with 4-by-4-inch junction box.
 - a. Mounting: [As indicated on Drawings] [Recess mounted, semiflush in wall] [Surface mounted on wall].
 3. Configuration, Rectangular: Rectangular push plate with 2-by-4-inch junction box.
 - a. Mounting: [As indicated on Drawings] [Recess mounted, semiflush in wall] [Recess mounted in door jamb] [Surface mounted on wall] [Surface mounted on post] [Surface mounted on guide rail].
 4. Push-Plate Material: [**Stainless steel**] [**Plastic**], as selected by Architect from manufacturer's full range.
 5. Message: [Plain face with no message.] ["Push to Open."] [International symbol of accessibility.] [International symbol of accessibility and "Push to Open."]
- H. Touchless Switch: Hands-free-activation door-control switch with flat motion sensor faceplate [**with contrasting-colored, engraved message**].
1. Configuration: [**6-inch round**] [**4.56-by-4.56-inch** (double gang) square] [**2.77-by-4.56-inch** (single gang) rectangular] [**1.68-by-4.56-inch** jamb-style] faceplate.
 - a. Mounting: [As indicated on Drawings] [Recess mounted in wall] [Recess mounted in door jamb] [Surface mounted on wall].
 2. Faceplate Material: [**Stainless steel**] [**Plastic**] [**Stainless steel with backlight acrylic window**], as selected by Architect from manufacturer's full range.
 3. Message: ["Wave to Open"] ["Wave to Open" and wave symbol] [International symbol of accessibility] [International symbol of accessibility, "Wave to Open," and wave symbol].
- I. Push-Button Switch: Momentary-contact door-control switch with one red-button actuator; enclosed in nominal [**2-by-4-inch**] [**4-by-4-inch**] junction box.
1. Provide faceplate engraved with "Press to Open" letters [**and international symbol of accessibility**] in contrasting color.

2. Provide blue plastic cover engraved with "Press Button to Open" in white letters and international symbol of accessibility.
 3. Mounting: [As indicated on Drawings] [Surface mounted on wall] [Surface mounted on post] [Surface mounted on guide rail] [Recess mounted in wall].
 4. Faceplate Material: **[Stainless steel]** **[Painted metal]**, as selected by Architect from manufacturer's full range.
- J. Key Switch: Recess-mounted, door-control switch with key-controlled actuator; enclosed in 2-by-4-inch junction box. Provide faceplate engraved with letters indicating switch functions.
1. Faceplate Material: **[Stainless steel]** **[Painted metal]**, as selected by Architect from manufacturer's full range.
 2. Functions: [On-off, momentary contact] [On-off, maintained contact] [Two-way automatic, hold open, one-way exit, and off] [Two-way automatic, hold open, one-way exit, off, full open, and partial open].
 3. Mounting: [As indicated on Drawings] [Recess mounted, semiflush in wall] [Recess mounted in door jamb] [Surface mounted on wall] [Surface mounted on post].
- K. Wireless or Remote Radio Control Switch: Auxiliary radio control system consisting of header-mounted receiver and **[wall-mounted]** **[hand-held, battery-operated]** transmitter switch **[for each entrance] <Insert requirement>**.
1. Wall-Mounted Transmitter Switch: One red-button, momentary-contact actuator enclosed in 4-by-4-inch junction box. Provide blue plastic cover engraved with "Press Button to Open" in white letters and international symbol of accessibility.
- L. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.07 HARDWARE

- A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish **[unless otherwise indicated]**.
- B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door to be as stipulated in "Performance Requirements" Article. Interrupt powered operation of door operator while in breakaway mode.
1. Include **[one adjustable detent device mounted at the top of each breakaway panel]** **[two adjustable detent devices mounted in each breakaway panel; one top mounted and one bottom mounted]** to control breakaway force.
 - a. Panel Closer: Factory-installed concealed hydraulic door closer.
 - b. Limit Arms: Limit swing to 90 degrees, spring loaded with adjustable friction damping.
- C. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum 1-inch-long throw bolt; BHMA A156.5, Grade 1.
1. Cylinders: **[BHMA A156.5, Grade 1, six-pin mortise type.]** **[As specified in Section 08 71 00 "Door Hardware."]** **[As specified in Section 08 71 11 "Door Hardware (Descriptive Specification)."]**

- a. Keying: **[No master]** **[Integrate into building master]** key system.
 - b. Keys: **[Two]** **[Three]** **<Insert number>** for each cylinder.
 2. Deadbolts: **[Laminated-steel hook]** **[Steel]**, mortise type, BHMA A156.5, Grade 1.
 3. Two-Point Locking for Stile and Rail Sliding Doors: Mechanism in stile of active door leaf that automatically extends second lockbolt into **[overhead carrier assembly]** **[threshold]**.
 4. Three-Point Locking for Stile and Rail Sliding Doors: Mechanism in stile of active door leaf that automatically extends lockbolts into overhead carrier assembly and threshold.
 5. Lock/Unlock Indicator: Lock position indicators integrated with locking system. Stile is mounted on secure side of door. Visual display of lock position as follows: "OPEN" in black letters when unlocked, and "LOCKED" in red letters when locked.
 6. Armored Strike: Reinforced security strike plate.
- D. Automatic Locking: Electrically controlled device mounted in header that automatically locks sliding door in closed position, preventing door panels from sliding manually. Provide fail-**[secure]** **[safe]** operation if power fails.
1. Power Interruption: **[Lock to be engaged, preventing doors from sliding manually]** **[Lock to be disengaged, allowing doors to slide manually]**.
 2. Means of Egress: Standard breakaway feature.
- E. Access-Control Locking: Electrically controlled device mounted in header that automatically locks sliding door in closed position, preventing door panels from sliding manually. Provide fail-**[secure]** **[safe]** operation if power fails.
1. Include concealed, vertical-rod, tamper-proof exit devices, complying with UL 305, with latching into threshold and overhead carrier assembly and released by **[full-width panic bar]** **[push paddle]**, **[surface mounted]** **[recessed]** **[flush mounted and concealed within horizontal muntin bar]**, prohibiting manual breakout of door(s) from exterior.
 2. Power Interruption: **[Lock to be engaged, preventing doors from sliding manually]** **[Lock to be disengaged, allowing doors to slide manually]**.
 3. Means of Egress: Vertical rod exit device.
 4. Include locking devices for sidelites to prevent manual breakout.
- F. Uninterrupted Power Supply: UL 1778, fully integrated unit mounted **[within header]** **[above ceiling]**.
1. Power Interruption: Supply power to operator, controls, activation device, and safety systems of sliding automatic door for up to **[1.5]** **<Insert number>** hours of normal operation.
 2. Include low-battery shutdown feature to safely open or close door prior to complete battery discharge.
 3. Include audible battery replacement alarm to indicate that battery will no longer accept a charge and replacement is required.
- G. Dustproof Strikes for All-Glass Sliding Doors: **[Recessed, floor type, BHMA A156.16, Grade 1, to receive deadbolt.]** **[As specified in Section 08 71 00 "Door Hardware."]** **[As specified in Section 08 71 11 "Door Hardware (Descriptive Specification)."]**

- H. Weather Stripping: Replaceable components.
 - 1. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.08 ACCESSORIES

A. Guide Rails:

- 1. **[Anodized aluminum] [Baked-enamel or powder-coated aluminum] [Stainless steel]**, fabricated from **[bars] [or] [tubing]**, minimum 30 inches high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated **[, but not less than that required by BHMA A156.10 for type of door and direction of travel]** <Insert requirement>; with filler panel.
 - a. Filler Panel: **[Expanded aluminum mesh] [Clear polycarbonate sheet] [Colored polycarbonate sheet]** <Insert material>.
 - 1) Orient expanded aluminum mesh with long dimension of diamonds **[parallel to top rail] [perpendicular to top rail]**.
 - 2) Color: **[Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.
 - b. Mounting: **[As indicated on Drawings] [Jamb and floor] [Floor, freestanding]**.
 - c. Aluminum Finish: **[Class I, clear anodic finish] [Class II, clear anodic finish] [Class I, color anodic finish] [Class II, color anodic finish] [Baked-enamel or powder-coat finish] [Finish matching door and frame]** <Insert finish>.
 - 1) Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities]** <Insert color>.
 - d. Stainless Steel Finish: **[No. 4 directional-satin-finish stainless steel] [Finish matching door and frame]** <Insert finish>.
- 2. See **[Section 05 52 13 "Pipe and Tube Railings."]** **[Section 05 73 00 "Decorative Metal Railings."]**

2.09 FABRICATION

- A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
 - 1. Form aluminum shapes before finishing.
 - 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - 3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws **[, finished to match framing] [, fabricated from stainless steel]**.
 - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

- b. Reinforce members as required to receive fastener threads.
 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 3. Form profiles that are sharp, straight, and free of defects or deformations.
 4. Provide components with concealed fasteners and anchor and connection devices.
 5. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
 6. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
 7. Allow for thermal expansion of exterior units.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Metal Cladding: Factory-fabricated and -installed metal cladding, completely covering all visible surfaces as part of prefabricated entrance assembly before shipment to Project site.
1. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 2. Form profiles that are sharp, straight, and free of defects or deformations.
 3. Provide components with concealed fasteners and anchor and connection devices.
 4. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
 5. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Allow for thermal expansion at exterior entrances.
- E. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- F. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, in accordance with NGA's "GANA Glazing Manual."
- G. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors [**and breakaway sidelites**].

H. Controls:

1. General: Factory install activation and safety devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.
2. Install photoelectric beams in vertical jambs of sidelites, with dimension above finished floor as follows:
 - a. Top Beam: **[48 inches]** <Insert dimension>.
 - b. Bottom Beam: **[24 inches]** <Insert dimension>.

2.10 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm]** **[AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- B. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm]** **[AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.
- D. High-Performance Organic Finish, Two-Coat: Fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.
- E. High-Performance Organic Finish, Three-Coat: Fluoropolymer finish complying with AAMA 2605 and containing not less than **[50]** **[70]** percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install automatic entrances in accordance with manufacturer's written instructions and cited BHMA A156.10 for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.
 - 1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
 - 2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
 - 3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.
- B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
 - 3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
 - 4. Level recesses for recessed thresholds using nonshrink grout.
- C. Door Operators: Connect door operators to electrical power distribution system.
- D. Access-Control Devices: Connect access-control devices to access-control system, as specified in Section 28 13 00 "Access Control Software and Database Management."
- E. Controls: Install and adjust activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel. Connect control wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- F. Guide Rails: Install rails in accordance with BHMA A156.10, including Appendix A, and manufacturer's written instructions unless otherwise indicated.
- G. Glazing: Install glazing as specified in [Section 08 80 00 "Glazing."] [Section 08 88 53 "Security Glazing."]

- H. Sealants: Comply with requirements specified in Section 07 92 00 "Joint Sealants" to provide weathertight installation.
 - 1. Set **[thresholds,] [bottom-guide-track system,]** framing members and flashings in full sealant bed.
 - 2. Seal perimeter of framing members with sealant.
- I. Signage: Apply signage on both sides of each door **[and breakaway sidelite]**, as required by cited BHMA standard for direction of pedestrian travel.
- J. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 FIELD QUALITY CONTROL

- A. Certified Inspector: **[Owner will engage] [Engage]** a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
- B. Perform the following tests and inspections **[with the assistance of a factory-authorized service representative]**:
 - 1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
- C. Automatic entrances will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust exterior doors for tight closure.
- B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- C. Occupancy Adjustments: When requested within **[12] <Insert number>** months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **[two] <Insert number>** visits to Project during other-than-normal occupancy hours for this purpose.

3.05 CLEANING

- A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
 - 1. Comply with requirements in **[Section 08 80 00 "Glazing"] [Section 08 88 53 "Security Glazing"]** for cleaning and maintaining glass.

3.06 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include **[three] [six] [nine] [12]** months' full maintenance by skilled employees of automatic entrance Installer. Include **[monthly] [quarterly]** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.
1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
 2. Perform maintenance, including emergency callback service, during normal working hours.
 3. Include 24-hour-per-day, 7-day-per-week emergency callback service.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION

SECTION 08 44 13

GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glazed aluminum curtain wall systems:
 - a. Conventionally glazed.
 - b. Two-sided, structural-sealant-glazed.

B. Related Requirements:

1. Section 01 43 39 "Mockups" for preconstruction laboratory mockup testing.
2. Section 01 91 19.43 "Exterior Enclosure Commissioning."
3. Section 07 84 43 "Joint Firestopping" perimeter fire-containment systems field installed with glazed aluminum curtain walls.
4. Section 07 92 00 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
5. Section 08 44 23 "Structural-Sealant-Glazed Curtain Walls" for four-sided structural-sealant-glazed curtain walls.
6. Section 08 44 33 "Sloped Glazing Assemblies" for sloped glazing.
7. Section 08 80 00 "Glazing" for curtain wall glazing.

1.02 ALLOWANCES

- A. [Preconstruction laboratory mockup] [Source quality-control] [and] [field quality-control] testing is part of testing and inspecting allowance.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
 1. <Insert requirements>.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 1. Joinery, including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
- F. Delegated-Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Mockup Testing Submittals:
 1. Testing Program: Developed specifically for Project.
 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- B. Qualification Data:
 1. For Installer [and laboratory mockup testing agency] [and field testing agency].
 2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the **[jurisdiction] [state]** in which Project is located.
- C. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
 1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

- D. Product Test Reports: For glazed aluminum curtain walls, for tests performed by **[manufacturer and witnessed by a qualified testing agency] [a qualified testing agency]**.
- E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranties: For special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors **[and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program]**.
- B. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated **[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025]**.
- C. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated **[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025]** and acceptable to Owner and Architect.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- E. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed curtain wall assemblies.

1.08 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.

2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: **[Owner will engage] [Engage]** a qualified testing agency to perform preconstruction testing on laboratory mockups.
1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
 2. Size and Configuration: As indicated on Drawings.
 3. Notify Architect **[seven] <Insert number>** days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.
- B. Preconstruction Laboratory Mockup Testing: Test preconstruction laboratory mockups according to requirements in "Performance Requirements" Article. Perform the following tests in the following order:
1. Structural, 50 percent: ASTM E330/E330M at 50 percent of positive test load.
 2. Air Leakage: ASTM E283.
 3. Water Penetration under Static Pressure: ASTM E331.
 4. Water Penetration under Dynamic Pressure: AAMA 501.1.
 5. Interstory Drift, 100 percent: AAMA 501.4 at 100 percent of design displacement. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 7. Thermal Cycling: AAMA 501.5. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 8. Structural, 100 percent: ASTM E330/E330M at 100 percent of positive and negative test loads. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 - c. Water Penetration under Dynamic Pressure: AAMA 501.1.
 9. Structural, 150 percent: ASTM E330/E330M at 150 percent of positive and negative test loads.

10. Interstory Drift, 150 percent: AAMA 501.4 at 150 percent of design displacement.

C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

1. Compatibility: Test materials or components using ASTM C1087.
2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
3. Submit no fewer than **[eight]** <Insert number> pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.10 WARRANTY

A. Special Assembly Warranty: **[Manufacturer]** **[Installer]** agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals **[, metal finishes,]** and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
2. Warranty Period: **[Two]** **[Five]** **[10]** <Insert number> years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: **[Five]** **[10]** **[20]** <Insert number> years from date of Substantial Completion.

- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: **[Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: **[As indicated on Drawings] <Insert loads>**.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to **[1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans of greater than 13 feet 6 inches] <Insert deflection limit>**.
 2. Deflection Parallel to Glazing Plane: Limited to **[amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch] <Insert deflection limit>**.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

3. Cantilever Deflection: Limited to $2l/175$ at unsupported cantilevers.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 2. When tested at **[150] <Insert number>** percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **[0.2] <Insert number>** percent of span.
 3. Test Durations: As required by design wind velocity, but not less than **[10] <Insert number>** seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
- G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
 2. Maximum Water Leakage: **[In accordance with AAMA 501.1] [No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation].** Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.
- H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
1. Design Displacement: **[As indicated on Drawings] <Insert design displacement>**.
 2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement **[and 1.5 times the design displacement].**
- I. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>**.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement **[and 1.5 times the design displacement].**
 2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.7 at design displacement **[and 1.5 times the design displacement].**
- J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than **[0.29 Btu/sq. ft. x h x deg F] [0.36 Btu/sq. ft. x h x deg F] [0.38 Btu/sq. ft. x h x deg F] [0.41 Btu/sq. ft. x h x deg F] [0.46 Btu/sq. ft. x h x deg F] [0.50 Btu/sq. ft. x h x deg F] <Insert value>** as determined in accordance with NFRC 100.

- b. Venting Windows: Whole window U-factor of not more than **[0.37 Btu/sq. ft. x h x deg F]** **[0.43 Btu/sq. ft. x h x deg F]** **[0.45 Btu/sq. ft. x h x deg F]** **[0.60 Btu/sq. ft. x h x deg F]** **[0.65 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than **[0.22]** **[0.25]** **[0.26]** **[0.29]** **[0.40]** **[0.45]** <Insert value> as determined in accordance with NFRC 200.
 - b. Venting Windows: Whole-window SHGC of not more than **[0.22]** **[0.27]** **[0.30]** **[0.40]** <Insert value> as determined in accordance with NFRC 200.
3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than **[0.06 cfm/sq. ft.]** <Insert value> at a static-air-pressure differential of **[1.57 lbf/sq. ft.]** **[6.24 lbf/sq. ft.]** <Insert value> when tested in accordance with ASTM E283.
 - b. Venting Windows: Whole-window air leakage of not more than **[0.3 cfm/sq. ft.]** <Insert value> at a static-air-pressure differential of **[6.24 lbf/sq. ft.]** <Insert value> when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than **[29]** **[55]** **[65]** **[80]** <Insert value> as determined in accordance with AAMA 1503.
 - b. Venting Windows: Whole-window CRF of not less than **[45]** **[52]** **[55]** <Insert value> as determined in accordance with AAMA 1503.
- K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:
 1. Outdoor-Indoor Transmission Class: Minimum **[26]** **[30]** **[34]** <Insert number>.
 2. Sound Transmission Class: Minimum **[31]** **[34]** **[37]** **[40]** <Insert number>.
- L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of **[180 deg F]** <Insert temperature>.
 - b. Low Exterior Ambient-Air Temperature: **[0 deg F]** <Insert temperature>.
- M. Structural-Sealant Joints:
 1. Designed to carry gravity loads of glazing.
- N. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.02 SOURCE LIMITATIONS

- A. Obtain all components of curtain-wall system [**and storefront system**], including framing [**spandrel panels**] [**venting windows**] [**entrances**] [**sun control**] <Insert component> and accessories, from single manufacturer.

2.03 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Construction: [**Thermally broken**] [**Thermally improved**] [**Nonthermal**] <Insert description>.
 2. Glazing System: [**Retained mechanically with gaskets on four sides**] [**Retained mechanically with gaskets on two sides and structural sealant on two sides**].
 3. Glazing Plane: [**Front**] <Insert location>.
 4. Finish: [**Clear anodic finish**] [**Color anodic finish**] [**Baked-enamel or powder-coat finish**] [**High-performance organic finish**] [**Superior-performance organic finish**].
 5. System: [**Either stick or unitized system**] [**Stick system**] [**Unitized system**].
 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 7. Steel Reinforcement: As required by manufacturer.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Insulated Spandrel Panels:
 1. Comply with Section 07 42 13.19 "Insulated Metal Wall Panels."
 2. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
 - a. Overall Panel Thickness: [**As indicated**] [**1 inch**] <Insert thickness>.
 - b. Exterior Skin: Aluminum.
 - 1) Thickness: [**Manufacturer's standard for finish and texture indicated**] <Insert thickness>.
 - 2) Finish: [**Match framing system**] <Insert finish>.
 - 3) Texture: [**Smooth**] [**Embossed**] <Insert texture>.

- 4) Backing Sheet: **[1/8-inch-thick, tempered hardboard]** **[0.157-inch-thick, cement board]** **[0.125-inch-thick, corrugated, high-density polyethylene]** <Insert material>.
- c. Interior Skin: **[Aluminum]** **[Manufacturer's standard galvanized-steel sheet]**.
- 1) Thickness: **[Manufacturer's standard for finish and texture indicated]** <Insert thickness>.
 - 2) Finish: **[Matching curtain-wall framing]** **[Low-gloss, white baked enamel]** **[Mill finish]** <Insert finish>.
 - 3) Texture: **[Smooth]** **[Embossed]** <Insert texture>.
 - 4) Backing Sheet: **[1/8-inch-thick, tempered hardboard]** **[0.157-inch-thick, cement board]** **[1/2-inch-thick, gypsum board with proprietary fire-resistance-rated core]** **[0.125-inch-thick, corrugated, high-density polyethylene]** <Insert material>.
- d. Thermal Insulation Core: Manufacturer's standard **[rigid, closed-cell, polyisocyanurate board]** **[extruded-polystyrene board]** **[expanded-perlite, mineral-insulation board]** <Insert insulation>.
- e. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- 1) Flame-Spread Index: **[25]** <Insert value> or less.
 - 2) Smoke-Developed Index: **[50]** **[450]** <Insert value> or less.
- E. Venting Windows:
1. As specified in Section 08 51 13 "Aluminum Windows."
 2. Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:
 - a. Window Type: **[Awning]** **[Casement]** **[As indicated on Drawings]** <Insert type>.
 - b. Minimum Performance Class: **[CW]** **[AW]** <Insert class>.
 - c. Minimum Performance Grade: **[30]** **[40]** **[60]** **[70]** **[80]** **[90]** **[As indicated on Drawings]** <Insert number>.
 - d. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
 - 1) Cam handle locking system.
 - 2) Multi-point locking system.
 - 3) Pole-operated, cam handle locking system, where rail is more than 72 inches above floor.
 - 4) Rotary operator.
 - 5) Steel or bronze operating arms.

- 6) Limit Devices: **[Concealed friction adjuster and adjustable stay bar]** **<Insert type>** limit devices designed to restrict sash opening.
 - (a) Limit clear opening to **[4 inches]** **<Insert dimension>** for ventilation; with custodial key release.
 - e. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
 - f. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
 - 1) Aluminum Wire Fabric: 18-by-18, 0.0445-inch-by-0.0445-inch; 18-by-16, 0.0445-inch-by-0.0515-inch; or 18-by-14, 0.0445-inch-by-0.0624-inch mesh of 0.013-inch-diameter, coated aluminum wire.
 - 2) Glass-Fiber Mesh Fabric: 18-by-16, 0.0445-inch-by-0.0515-inch or 18-by-14, 0.0445-inch-by-0.0624-inch mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
 - 3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.
 - g. Glazing: **[As specified in Section 08 80 00 "Glazing"]** **[Same as adjacent glazed aluminum curtain-wall glazing]** **<Insert glazing>**.
 - h. Finish: **[Match adjacent glazed aluminum curtain-wall finish]** **<Insert finish>**.
- F. Entrance Door Systems: Comply with **[Section 08 41 13 "Aluminum-Framed Entrances and Storefronts"]** **[Section 08 42 13 "Aluminum-Framed Entrances"]**.

2.04 SUN CONTROL

- A. Sunshades: Assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.
 - 1. Orientation: **[Horizontal]** **[Vertical]**.
 - 2. Projection from Wall: **[As indicated on Drawings]** **[20 inches]** **[25 inches]** **[30 inches]** **[35 inches]** **<Insert projection>**.
 - 3. Outriggers: **[Straight with square edges]** **[Straight with rounded edge]** **[Curved]** **[Wedge]** **<Insert shape>**.
 - 4. Louvers:
 - a. Number: **[Three]** **[Four]** **[Five]** **<Insert number>** louvers per unit.
 - b. Shape: **[Planar]** **[Arched]** **[Circular]** **[Airfoil]** **[Square]**.
 - c. Width: **[6 inches]** **[8 inches]** **[10 inches]** **<Insert dimension>**.
 - d. Mounting Angle: **[25]** **[30]** **[35]** **<Insert number>** degrees.
 - 5. Fasciae: **[Rectangular]** **[Bullnose]** **[Angular]** **[Circular]**.
 - 6. Finish: **[Match adjacent glazed aluminum curtain wall]** **<Insert finish>**.
 - 7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

8. Steel Reinforcement: As required by manufacturer.
- B. Light Shelves: Light-reflecting assemblies consisting of manufacturer's standard support brackets or channels, and aluminum tray, designed for attachment to interior of curtain wall with mechanical fasteners.
1. Projection from Wall: [As indicated on Drawings] [20 inches] [25 inches] [30 inches] [35 inches] <Insert projection>.
 2. Finish: [Match adjacent glazed aluminum curtain wall] <Insert finish>.
 3. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 4. Steel Reinforcement: As required by manufacturer.

2.05 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."
- B. Glazing Gaskets: ASTM C509 or ASTM C864. [Manufacturer's standard] [Compression-type, replaceable EPDM] [Extruded silicone] [Comply with Section 08 80 00 "Glazing."] <Insert type>.
1. Color: [Black] <Insert color>.
- C. Glazing Sealants: [As recommended by manufacturer.] [Comply with Section 08 80 00 "Glazing."]
- D. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
1. Color: [Black] [Gray] [As selected by Architect from manufacturer's full range of colors] <Insert color>.
- E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
1. Color: Match structural sealant.

2.06 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.07 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads [, finished to match framing system] [, fabricated from 300 series stainless steel].
- B. Anchors: Three-way adjustable anchors with minimum adjustment of **[1 inch] <Insert dimension>** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: [Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials] [Dead-soft, **0.018-inch**-thick stainless steel, ASTM A240/A240M of type recommended by manufacturer].
- D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

2.08 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from [exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels].
 - 6. Provisions for safety railings mounted [on interior face of mullions] [between mullions at interior].
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
 - 8. Components curved to indicated radii.

- D. Fabricate components to resist water penetration as follows:
1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
 2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Curtain-Wall Framing: Fabricate components for assembly using [manufacturer's standard assembly method] [shear-block system] [screw-spline system] [head-and-sill-receptor system with shear blocks at intermediate horizontal members] <Insert description>.
- F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
 2. Prepare surfaces that are in contact with structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 3. Seal joints watertight unless otherwise indicated.
 4. Install glazing to comply with requirements in Section 08 80 00 "Glazing."
 5. Install structural glazing.
 - a. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
 - b. Set glazing with proper orientation so that coatings face exterior or interior as specified.
 - c. Apply structural silicone sealant to completely fill cavity, in accordance with sealant manufacturers written instructions with the framing and glazing in a fully supported position.
 - d. Brace or stiffen framing and glazing in such a manner to prevent undue stresses on the glass edge seal and structural joints or movement of the glazing, until sealant is fully cured in accordance with manufacturer's recommendations.
 - e. After structural sealant has completely cured, insert backer rod between lites of glass as recommended by sealant manufacturer.
 - f. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.
 - g. Clean and protect glass as indicated in Section 08 80 00 "Glazing."
 - h. Retain bracing or stiffening until erected to prevent racking of units during transportation and erection.
- G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.
- H. <Insert requirements>.

2.09 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.

- B. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Champagne] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [AAMA 2604] [AAMA 2605] and containing not less than [50] [70] percent PVDF resin by weight in color coat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- G. Superior Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.10 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
- G. Seal joints watertight unless otherwise indicated.
- H. Metal Protection:
 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- J. Install components plumb and true in alignment with established lines and grades.

3.03 INSTALLATION OF OPERABLE UNITS

- A. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

3.04 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 08 80 00 "Glazing."

3.05 INSTALLATION OF STRUCTURAL GLAZING

- A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
- B. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
- C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.
- D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.
- E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.
- F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
- G. Allow structural sealant to cure in accordance with manufacturer's recommendations.
- H. Clean and protect glass as indicated in Section 08 80 00 "Glazing."

3.06 INSTALLATION OF WEATHERSEAL SEALANT

- A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.
- B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.07 ERECTION TOLERANCES

- A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Test Area: Perform tests on **[one bay at least 30 feet, by one story] [representative areas of glazed aluminum curtain walls] [mockups] <Insert requirements>**.
- C. Field Quality-Control Testing: Perform the following test on **[representative areas of glazed aluminum curtain walls] [mockups] <Insert requirements>**.
 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of **[two] [three] <Insert number>** tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to **[10, 35, and 70 percent completion] <Insert requirements>**.
 2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - a. Perform a minimum of **[two] [three] <Insert number>** tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to **[10, 35, and 70 percent completion] <Insert requirements>**.
 3. Water Penetration: ASTM E1105 at a minimum **[uniform] [and] [cyclic]** static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
- D. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 1. Test a minimum of **[two] [four] [six] <Insert number>** areas on each building facade.
 2. Repair installation areas damaged by testing.
- E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

SECTION 08 51 00

METAL WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aluminum windows.

1.02 DEFINITIONS

- A. Combination Assemblies: An assembly formed by a combination of two or more separate fenestration products whose frames are mullied together utilizing a combination mullion or reinforcing mullion.
- B. Combination Mullions: A horizontal or vertical member formed by joining two or more individual fenestration units together without a mullion stiffener.
- C. Reinforcing Mullions: A horizontal or vertical member with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.03 COORDINATION

- A. Finish Matching: Coordinate all exposed exterior aluminum components and trim to ensure uniform and consistent color and appearance. Use products specified in **[this Section] <Insert Section number and title>** as a benchmark. Architect's decision will be final as to whether a proposed product matches.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review and discuss finishing of aluminum windows that is required to be coordinated with finishing of other aluminum work for color and finish matching.
3. Review, discuss, and coordinate interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
4. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.
5. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.
 - B. Shop Drawings:
 - 1. Plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
 - C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
 - D. Samples for Verification: Actual sample of finished products for each type of exposed finish:
 - 1. Exposed Aluminum Finishes: [Manufacturers' standard size] **[2 by 4 inches]** <Insert dimensions>.
 - 2. Exposed Hardware: Full-size units.
 - E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.
- 1.06 INFORMATIONAL SUBMITTALS
- A. Test and Evaluation Reports:
 - 1. Product Test Reports: For each aluminum window, for tests performed by [qualified testing agency] [manufacturer and witnessed by a qualified testing agency].
 - B. Field Quality-Control Reports: For aluminum windows.
 - C. Qualification Statements: For manufacturer and Installer.
 - D. Sample warranties.
- 1.07 CLOSEOUT SUBMITTALS
- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
- 1.08 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
 - B. Installer Qualifications: Authorized representative who is trained and approved by aluminum window manufacturer.
 - C. Testing Agency Qualifications: An FGIA-accredited testing agency for testing indicated.
- 1.09 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution. **[See Section 01 43 39 "Mockups" for additional construction requirements for integrated exterior mockups.]**
1. Build mockup [as indicated on Drawings] <Insert mockup requirements>.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver aluminum windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect aluminum windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle aluminum windows in a manner that prevents damage before, during, and after installation.

1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not install aluminum windows outside of limits recommended in writing by manufacturer.

1.12 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures, including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.
 2. Warranty Period:
 - a. Window: **[Two] [Five] [10]** <Insert number> years from date of Substantial Completion.
 - b. Glazing Units: **[Five] [10]** <Insert number> years from date of Substantial Completion.

- c. Hardware: **[Three]** <Insert number> years from date of Substantial Completion.
- d. Aluminum Finish: **[10] [20]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain aluminum windows from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: FGIA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: **[R] [LC] [CW] [AW]** [As indicated on Drawings] <Insert class>.
 - 2. Minimum Performance Grade: **[15] [20] [25] [30] [35] [40] [45] [50]** [As indicated on Drawings] <Insert grade>.
 - 3. Muller Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.
- C. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 - 1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:
 - a. Fixed Windows: Not more than **[0.50 Btu/sq. ft. x h x deg F]**
[0.45 Btu/sq. ft. x h x deg F] **[0.42 Btu/sq. ft. x h x deg F]**
[0.36 Btu/sq. ft. x h x deg F] **[0.34 Btu/sq. ft. x h x deg F]**
[0.29 Btu/sq. ft. x h x deg F] **[0.26 Btu/sq. ft. x h x deg F]** <Insert value>.
 - b. Operable Windows: Not more than **[0.62 Btu/sq. ft. x h x deg F]**
[0.60 Btu/sq. t. x h x deg F] **[0.54 Btu/sq. ft. x h x deg F]**
[0.45 Btu/sq. ft. x h x deg F] **[0.42 Btu/sq. ft. x h x deg F]**
[0.36 Btu/sq. ft. x h x deg F] **[0.32 Btu/sq. ft. x h x deg F]** <Insert value>.
 - 2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:
 - a. Fixed Windows: Not more than **[0.23] [0.25] [0.36] [0.38] [0.40]** <Insert value>.
 - b. Operable Windows: Not more than **[0.21] [0.23] [0.33] [0.34] [0.36]** <Insert value> as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of **[45] [52]** <Insert value>.
 - D. Thermal Movements: Provide aluminum windows, including anchorage, which allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: **[120 deg F ambient; 180 deg F material surfaces]** <Insert temperature change>.
 - E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than **[22] [26] [30]** <Insert rating> OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.
- 2.03 ALUMINUM WINDOWS <Insert drawing designation>
- A. Provide manufacturer's standard aluminum window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.
 - B. Operating Types: Provide the following operating types in locations indicated on Drawings:
 1. Casement: **[Outswing] [Inswing]**.
 2. Projected, awning.
 3. Projected, hopper.
 4. Single hung.
 5. Double hung.
 6. Horizontal sliding.
 7. Fixed.
 - C. Frames and Sashes: Aluminum extrusions of alloy, temper, and strength complying with AAMA/WDMA/CSA 101/I.S.2/A440.
 1. Thermally Broken Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
 - D. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.
 1. Kind: Fully tempered **[where indicated on Drawings]** <Insert requirements>.
 - E. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172, with two plies of float glass.

1. Float Glass: [Annealed] [Heat strengthened] [Fully tempered] [As required by performance requirements indicated].
 2. Inner Ply: Clear.
 3. Interlayer: [0.090 inch] [As required by performance requirements indicated] <Insert requirements>.
 4. Outer Ply: [Clear] [Gray] [Bronze] [Green] <Insert tint>.
 5. Low-E Coating: [Pyrolytic on second surface] [Sputtered on second surface] [Sputtered on third surface] [Sputtered on second or third surface] <Insert coating>.
- F. Insulating-Glass Units: ASTM E2190.
1. Glass: ASTM C1036, Type 1, Class 1, q3.
 - a. Tint: [Clear] [Gray] [Bronze] [Green] <Insert tint>.
 - b. Kind: Fully tempered [where indicated on Drawings] <Insert requirements>.
 2. Lites: [Two] [Three].
 3. Filling: Fill space between glass lites with [air] [argon].
 4. Low-E Coating: [Pyrolytic on second surface] [Sputtered on second surface] [Sputtered on third surface] [Sputtered on second or third surface] <Insert coating>.
 5. Integral Louver Blinds: Provide glass manufacturer's standard, horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between glass lites, and operated by hardware located on inside face of sash.
 - a. Operation: [Tilt only] [Tilt, raising, and lowering].
 - b. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- G. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190, with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.
1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.
 - a. Tint: [Clear] [Gray] [Bronze] [Green] <Insert tint>.
 - b. Kind: [Heat strengthened] [Fully tempered].
 2. Interior Lite: ASTM C1172, clear laminated glass with two plies of float glass.
 - a. Float Glass: [Annealed] [Heat strengthened] [Fully tempered] [As required by performance requirements indicated].
 - b. Interlayer Thickness: [0.090 inch] [As required by performance requirements indicated] <Insert requirements>.
 3. Filling: Fill space between glass lites with [air] [argon].

4. Low-E Coating: [Pyrolytic on second surface] [Sputtered on second surface] [Sputtered on third surface] [Sputtered on second or third surface] <Insert coating>.
- H. Glazing System: [Manufacturer's standard factory-glazing system that produces weathertight seal] <Insert glazing requirements>.
1. Dual Glazing System:
 - a. Interior Lite: [Glass] <Insert type>.
 - b. Exterior Lite: [Glass] [Insulating-glass unit] <Insert type>.
- I. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
1. Exposed Hardware Color and Finish: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and finish>.
- J. Window Hardware: [Casement] [and] [projected].
1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.
 - a. Type and Style: [Match Architect's sample] [As selected by Architect from manufacturer's full range of types and styles] <Insert type and style>.
 2. Hinges: [Non-friction type, not less than two per sash] <Insert requirements>.
 3. Lock: [Lift-type throw, cam-action lock with keeper] [Lever handle and cam-action lock with keeper] [Dual lever handles, tie rod, and cam-action lock with keepers] [Key-operated custodial lock with keeper and removable handle] [Concealed multipoint lock operated by single lever handle or lift-type throw] <Insert requirements>.
 4. Limit Devices: [Concealed friction adjustor, adjustable stay bar] [Concealed support arms with adjustable, limited, hold-open] <Insert type> limit devices designed to restrict sash opening.
 - a. Limit clear opening to [4 inches] <Insert dimension> for ventilation; with custodial key release.
 5. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches above floor.
- K. Hung Window Hardware:
1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.

2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. [**Provide key-operated custodial locks.**]
3. Tilt Latch: Releasing latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

L. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [Extruded-aluminum track with natural anodized finish] [Manufacturer's standard] <Insert track material and finish> of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. [**Provide key-operated custodial locks.**]
3. Roller Assemblies: Low-friction design.

M. Weather Stripping: Provide manufacturer's standard full-perimeter weather stripping for each operable sash unless otherwise indicated.

N. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

O. Mullions: Provide manufacturer's standard combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.04 ACCESSORIES

A. Dividers (False Muntins): Provide manufacturer's standard extruded-aluminum divider grilles in designs indicated for each sash lite.

1. Type: [Permanently located at exterior lite] [Permanently located between insulating-glass lites] <Insert type>.
2. Pattern: [As indicated on Drawings] <Insert pattern>.
3. Profile: [As selected by Architect from manufacturer's full range] <Insert profile>.

B. Subsills: [Thermally broken] [Nonthermal], extruded-aluminum subsills in configurations indicated on Drawings.

C. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

D. Panning Trim: Profiles in sizes and configurations indicated on Drawings.

- E. Nail Fins: Manufacturer's standard mounting flanges with holes pre-punched for mechanical fasteners.

2.05 INSECT SCREENS

- A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
 - 1. Type and Location: [Full, inside for outswing] [Full, inside for projected, awning] [Full, outside for inswing] [Full, outside for projected, hopper] [Full, outside for double-hung] [Half, outside for single-hung] [Full, outside for sliding] [Half, outside for sliding] sashes.
- B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
 - 1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
- C. Glass-Fiber Mesh Fabric: [18-by-14 or 18-by-16] [20-by-20 or 20-by-30] <Insert type> mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.
 - 1. Mesh Color: [Manufacturer's standard] <Insert color>.
- D. Aluminum Wire Fabric: 18-by-16 mesh of 0.011-inch-diameter, coated aluminum wire.
 - 1. Wire-Fabric Finish: [Natural bright] [Charcoal gray] [Black] <Insert finish>.

2.06 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.
- F. Window Assemblies: [Bow] [Bay] [Combination]. Provide window units in configuration indicated on Drawings. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
 - 1. Combination and reinforcing mullions with interior and exterior trim.
 - 2. Interior and exterior extension and trim.
 - 3. Exterior head and sill casings and trim.

- G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.07 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.08 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- C. Baked-Enamel or Powder-Coat Finish: [AAMA 2603] [AAMA 2604] except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- D. Organic Coatings:
 - 1. High-Performance Fluoropolymer Finish: Two coats complying with [AAMA 2604,] [AAMA 2605,] containing not less than [50] [70] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
 - 2. Superior-Performance Fluoropolymer Finish: [Three] [Four] coats complying with AAMA 2605, containing not less than [50] [70] percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, **[vapor retarders,]**air and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.
- D. Install windows and components to drain water passing joints and condensation to the exterior.
- E. Separate aluminum from sources of corrosion or electrolytic action at points of contact with other materials.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
 - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspection of installed windows as follows:
 - 1. Testing Methodology: Testing of windows for air infiltration and water resistance in accordance with AAMA 502.
 - 2. Air-Infiltration Testing:
 - a. Test Pressure: As required to determine compliance in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for performance class indicated.
 - b. Allowable Air-Leakage Rate: **[1.5] <Insert number>** times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:
 - a. Test Pressure: **[Two-thirds]** <Insert number> times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
4. Testing Extent: **[One] [Three]** <Insert number or description> window(s) of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows will be tested **[immediately after installation] [at 5, 50, and 90 percent completion]** <Insert test schedule>.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Tests and Inspections:

1. Windows will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.05 CLEANING AND PROTECTION

- A. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Avoid damaging finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 08 56 59

SERVICE AND TELLER WINDOW UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Include:

1. Exterior cashier windows with built-in counters and Speak Holes, Type ___ in the Window Schedule.
2. Glass and glazing for the work of this Section.
3. Manual pass, service and teller window units.
4. Bullet resistant pass, service and teller window units.
5. Drawers.
6. Glazing.
7. Air curtains.
8. Deal trays and shelves.
9. Intercom and talk through.

B. Related Requirements:

1. Section 07 62 00: Sheet Metal Flashing and Trim.
2. Section 07 92 00: Joint Sealants
3. Division 08 for all other windows and for glass and glazing.

1.02 SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for window assemblies.

B. Shop Drawings:

1. Include window and counter plans, elevations, sections, and attachments to other work.
2. Full-size section details of framing members along with reinforcement, and stiffeners.
3. Location of weep holes.
4. Glazing details.

C. Samples:

1. Window manufacturer's standard size samples for each type of exposed material and finish required.
2. Framing: 12-inch- long sections of frame members.

D. Test Reports: Indicate compliance with specified bullet resistance performance.

E. Manufacturer's Installation Instructions: Submit installation instructions with requirements to accommodate specific site conditions.

F. Manufacturer's written instructions, including:

G. Delivery, storage, and handling recommendations.

H. Preparation and installation recommendations.

I. Installer's Experience: Submit verification of evidence of work similar to work of this Section.

J. Sample Warranty: For special warranty.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Windows shall conform to the reach and access requirements of CBC Section 11B for accessible transaction areas.
 2. Accessible pass-through shelf shall not exceed 34 inches above finished floor surface.
- B. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 10 years documented experience.
- C. Installer Qualifications: Authorized representative who is trained and approved by manufacturer for installation of units required for this Project.
- D. Products Requiring Electrical Connection: Listed and classified by UL or testing firm acceptable to authority having jurisdiction.
- E. Testing Agency Qualifications:
1. Qualified according to ASTM E699 and experienced in [~~ballistics-~~] [~~and~~] [~~forced-entry-~~] resistance testing.
- F. Products Requiring Electrical Connection: Listed and classified by UL or testing firm acceptable to authority having jurisdiction.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Pack assemblies in wood crates for shipment. Crate glazing separate from frames unless factory glazed.
- B. Label packaging with drawing designation.
- C. Store crated assemblies on raised blocks to prevent moisture damage.

1.05 FIELD CONDITIONS

- A. Field-Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace service windows that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including deflections exceeding 1/4 inch.
 - b. Failure of welds.
 - c. Excessive air leakage.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 2. Warranty Period: 3 years from Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. System Design: Design and size components to withstand dead loads and live loads caused by pressure and negative wind loads acting normal to plane of window as calculated in accordance with applicable code.
- B. System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, and migrating moisture occurring within system, to exterior by weep drainage network.
- C. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with [~~inside~~] pane of glass and heel bead of glazing compound. [~~Position thermal insulation on exterior surface of air barrier and vapor retarder.~~]

- D. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
1. Listed and labeled as bullet resisting according to UL 752.
 2. Tested for ballistics resistance according to UL 752, [HPW-TP-0500.01], [HPW-TP-0500.02] [] by a testing agency acceptable to authorities having jurisdiction.
- E. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
1. Tested for forced-entry resistance according to ASTM F588 [] by a testing agency acceptable to authorities having jurisdiction.
 2. California Model Building Security Ordinance, CMBSO - Section 15.52.100, Tests CAWM 301-90, Forced Entry Resistance Tests for Windows.
 3. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
 4. To utilize the inner pane of multiple pane sealed units for the continuity of the air barrier and vapor retarder seal.
- F. Structural Design: Design glass and glazing in accordance with [applicable] [] code for most critical combination of wind, snow, seismic, and dead loads.
- G. Heating and cooling type equipment to comply with UL 1995.

2.02 TRANSACTION WINDOWS

- A. Manufacturers:
1. Teller Window and Deal Tray combination by Quikserv, basis of design.
 2. Acceptable manufacturers include the following:
 - a. Laurence, C.R. Co., Inc.
 - b. Ready-Access
 - c. Or equal.

2.03 MATERIALS

- A. Aluminum Extrusions: ASTM B221/B221M. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength and not less than 0.125 inch (3.2 mm) thick at any location for main frame and sash members.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Metallic-Coated Steel Sheet:
1. ASTM A653/A653M, CS (Commercial Steel), Type B; with G90 (Z275) zinc (galvanized) coating designation.
 2. AMS 5511, steel, corrosion-resistant, sheet, strip, and plate, 19Cr - 9.5Ni (304L), solution heat treated.
 3. AMS 5513, steel, corrosion-resistant, sheet, strip, and plate 19cr 9.2Ni (SAE 30304) solution heat treated.
- D. Stainless Steel Sheet, Strip, Plate, and Flat Bars:
1. ASTM A666, austenitic stainless steel, Type 304, stretcher-leveled standard of flatness.
 2. ASME SA-240/SA-240M, chromium and chromium-nickel stainless steel plate, sheet, and strip for general applications.
- E. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.
- F. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to [four] [] times the load imposed, as determined by testing per ASTM E488, conducted by a qualified testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A27/A27M cast steel or ASTM A47/A47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized per ASTM A153/A153M or ASTM F2329.
- G. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch thick; with minimum 1/2-inch- diameter, headed studs welded to back of plate..
- H. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 1. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.
- I. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating.
- J. Gaskets: For gaskets required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Gaskets shall remain permanently elastic, nonshrinking, and nonmigrating.

2.04 WINDOW COMPONENTS

- A. Comply with requirements of UL listing for ballistics-resistance levels as specified.
- B. Glass:
 1. Tempered Glass: 1/4 inch thick.
 2. Insulated Glass: 5/8 inch thick overall thickness.
- C. Bullet Resistant Glazing:
 1. Model QSBR - Sheet:
 - a. LEXGARD® MP750 Level 1 - 9mm or .38 Special caliber rated.
 - b. SPARTECH POLYCAST MP 1.25 Level 1- 9mm or .38 Special caliber rated.
 - c. LEXGARD® SP1250 Level 3 - .44 Magnum caliber rated.
- D. Track/Slides: Stainless steel ball bearing slides on all windows and drawers.
- E. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers, and with a proven record of compatibility with surfaces contacted in installation:
 1. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
 2. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.
 3. Spacers: Elastomeric blocks or continuous extrusions with a Type A Shore durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Flashing.
- G. Welding Materials.
- H. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, of sufficient strength to withstand design pressure indicated.

2.05 FABRICATION

- A. General: Fabricate windows to provide a complete system for assembly of components and anchorage of window units with countertops. Provide units that are re-grazable from the secure side without dismantling the non-secure side of framing.

- B. Provide weep holes and internal water passages to conduct infiltrating water to the exterior.
- C. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.
- D. Prior to fabrication, clean stainless-steel components.
- E. Fabricate window in accordance with approved Shop Drawings, to a tolerance of plus or minus 1/16-inch in any dimension, free of rack, and with flush, invisible joints.
- F. Fabricate frames of 1/8-inch wall 6063-T5 Aluminum lined with bullet-resistant fiberglass and wrapped in 16-gage stainless steel.
- G. Miter or cope corners of frame and weld continuously.
- H. The deal tray shall be fully integrated into the stainless steel top. Drawer shall have a minimum depth of 1-5/8-inch from the bottom of the glazing.
- I. Voice communication:
 - 1. Stainless voice port shall be the manufacturer standard unit, offset pattern design, with proper weather seals.
 - 2. Sound transmission shall be achieved thru natural voice communication.
 - 3. Factory-install speak hole. Conceal all raw glass edges.
- J. Glazing:
 - 1. Design window for inside glazing. Provide integral exterior glass stop.
 - 2. Provide continuous screw on interior stainless-steel glazing beads to suit glass indicated and specified, using glass bites indicated on the approved Shop Drawings to maintain the ballistic rating.
- K. Anchors: Ship loose for field installation. Provide a minimum of 3 anchors per side, not less than 0.042-inch thick or 0.167-inch diameter wire, suitable for the adjoining wall construction.
- L. Finishing exposed surfaces:
 - 1. Finish surfaces to match approved Samples.
 - 2. Finish components with a NAAMM No. 4 satin finish with the grain belting running parallel with the long dimension of the component being fabricated.

2.06 GENERAL FINISH REQUIREMENTS

- A. Finish components with a NAAMM No. 4 satin finish with the grain belting running parallel with the long dimension of the component being fabricated.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of windows.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of windows.
- C. For glazing materials whose orientation is critical for performance, verify installation orientation.
- D. Proceed with installation only after unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other security window anchors whose installation is specified in other Sections. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.

3.03 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing windows to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.
- B. Glazed Framing: Provide gasket-glazed framing. Comply with installation requirements in Division 08 Section "Security Glazing."
- C. Removable Glazing Stops and Trim: Fasten components with security fasteners.
- D. Fasteners: Install windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel fasteners in stainless-steel materials.
- E. Sealants: Comply with requirements in Division 07 Section "Joint Sealants" for installing sealants, fillers, and gaskets.
 - 1. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction unless otherwise indicated.
 - 2. Seal frame perimeter with sealant to provide weathertight construction unless otherwise indicated.
- F. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.04 FIELD QUALITY CONTROL

- A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
- B. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

3.05 ADJUSTING

- A. Remove and replace defective work, including windows that are warped, bowed, or otherwise unacceptable.

3.06 CLEANING AND PROTECTION

- A. Clean surfaces promptly after installation of windows. Take care to avoid damaging the finish. Remove excess glazing and sealant compounds, dirt, and other substances.
- B. Provide temporary protection to ensure that windows are without damage at time of Substantial Completion.

END OF SECTION

SECTION 08 62 23
TUBULAR SKYLIGHTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes tubular skylights consisting of skylight dome, reflective tube, and diffuser assembly.
- B. Related requirements: Division 07 for membrane roofing for flashing skylight base.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing
- B. Pre-installation meeting

1.03 REFERENCES

- A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2001.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process; 2001a.
- C. ASTM E 283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- D. ASTM E 308-95 - Standard Practice for Computing the Colors of Objects by Using the CIE System.
- E. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors.
- F. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain walls and Doors by Static Air Pressure Difference.
- G. ASTM D 635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.
- H. ASTM D-1929 - Test Method for Ignition Properties of Plastics.
- I. UL 181 - Factory Made Air Ducts and Air Connectors; 1998.
- J. UL 790 - Standard for Tests for Fire Resistance of Roof Covering Materials; 1997.
- K. ICBO/ICC AC-16 - Acceptance Criteria for Plastic Skylights; 2002.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Performance: Completed skylight assemblies shall be capable of meeting the following performance requirements:
1. Air infiltration test: None at 6.24 psf pressure differential when tested in accordance with ASTM E283.
 2. Water resistance test: No leakage at 6.00 psf pressure differential with water rate of 5 gallons/hours/square foot when tested in accordance with ASTM E331.
 3. Uniform load test: No breakage, permanent damage to fasteners, hardware parts, or damage to make tubular skylight inoperable, or cause permanent deflection of any section in excess of one percent of its span at either a maximum Positive or Negative Load of 35 psf for the 21-inch unit. Units shall be tested with a safety factor of 3 for positive pressure and 2 for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.
 4. Fire resistance:
 - a. Class 'B' Burning Brand – The burning brand shall self-extinguish without transferring the fire to the dome Per CBC Class 'B' Burning Brand Test. See ASTM E 108 and UL 790.
 - b. Self-ignition temperature: Greater than 650 degrees F Per CBC. See ASTM D-1929.
 - c. Smoke density: Rating no greater than 75 Per: U.B.C. Standard 26-5. (See ASTM D-2843-70) or no greater than 450 Per UBC 8-1 (See ASTM Standard E 84) in way intended for use.
 - d. Rate of burn - minimum burning rate: 2.5 inches/minute Classification CC-2: CBC and ASTM D 635.

1.05 SUBMITTALS

- A. Data: Manufacturer Product Data sheets on each product to be used, including.
- a. Preparation instructions and recommendations.
 - b. Storage and handling requirements and recommendations.
 - c. Installation methods.
- B. Shop Drawings: Show attachment to supports and a section thru the unit detailing flashing to roof.
- C. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

1.06 HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.07 WARRANTY

- A. Skylight manufacturer's standard 10-year warranty.

PART 2 PRODUCTS

2.01 MANUFACTURER / MODEL

- A. Manufacturer: Solatube International, Inc.
- B. Model: Solatube SolaMaster Series.

2.02 TUBULAR SKYLIGHTS

- A. General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16. II components made and assembled by one manufacturer.
- B. Components: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 - 1. Dome glazing: 0.143-inch minimum thickness injection molded acrylic classified as CC2 material and meeting characteristics of Duradome DR-101 blend.
 - 2. Low-angled sun reflector: LITD(r) light intercepting transfer device, made of same material as main tube, to capture low angle sunlight.
 - 3. Roof flashing base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
 - a. Base material: Sheet steel, corrosion resistant conforming to ASTM A 653/A 653M or ASTM A 463/A 463M, 0.028-inch thick.
 - b. Base style: Self mounted, 11 inches high.
 - 4. Dome ring: Attached to top of base section; 0.090-inch nominal thickness. Injection molded high impact ABS; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
 - 5. Dome seal: Polypropylene fiber pile weather – strip 0.27-inch by 0.27-inch.
 - 6. Reflective tube: Aluminum sheet 0.015-inch thick.
 - a. Interior finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface; specular reflectance 99 percent for visible spectrum, less than 93 percent for total solar spectrum at 1.5 degree field angle.
 - b. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
 - c. Tube diameter: As indicated.
 - 7. Diffuser assemblies: Diffuser attached directly to bottom of tube.
 - a. Lens: Curved prismatic lens of molded acrylic plastic classified as CC2, 0.028-inch minimum thickness, minimum light transmission of 90 percent at thickness of 0.125-inch.
 - b. Seal: Closed cell polyethylene foam, 3 pcf, and white polyvinyl chloride seal butt joint welded, EPDM rubber, or silicone foam.
 - 8. Accessories: Security Bars 0.375-inch diameter stainless steel bar across opening.

2.03 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.
- B. Sealant: As specified in Section 07 92 00 and compatible with roofing membrane.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine adjacent construction and supports.
- B. Verify that openings are within allowable tolerances, plumb, level, clean, will provide a solid anchoring surface.
- C. Correct detrimental conditions before proceeding with installation.

3.02 INSTALLATION

- A. Install skylights plumb, in accordance with the approved Shop Drawings and the skylight manufacturer's instructions. Attach securely to supports.
- B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Architect. Correct if needed before proceeding with installation of subsequent units.

3.03 PROTECTION

- A. Protect installed skylights until completion of Project.
- B. Touchup, repair or replace damaged components before Substantial Completion.

END OF SECTION

SECTION 08 63 00
METAL-FRAMED SKYLIGHTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes skylights with metal framing.
- B. Related Requirements:
 - 1. Section 084433 "Sloped Glazing Assemblies" for glazed curtain walls in which the glazed panels are primarily on a sloped plane.
 - 2. Section 086200 "Unit Skylights" for skylights without framing except at the perimeter of the glazing.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
 - 2. Motors: Show nameplate data, power requirements, ratings, characteristics, and mounting arrangements.
- B. Shop Drawings: For metal-framed skylights.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Indicate structural loadings and reactions to be transmitted to supporting curbs.
 - 3. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
 - 4. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:
 - a. Joinery including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - f. Or Equal.
 - 5. Manual Operators: Show locations, mounting, and details for installing operator components and controls.

6. Motor Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 - a. Wiring Diagrams: For power, signal, and control wiring for electric motors of operable metal-framed skylights.
 - C. Samples for Initial Selection: For units with factory-applied finishes.
 - D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
 - E. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 1. Joinery including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
 - F. Delegated Design Submittal: For metal-framed skylights indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Compatibility and Adhesion Test Reports: For structural-sealant-glazed skylights, test reports from sealant manufacturer indicating that joint sealants have been tested for each material that will come in contact with sealants.
 - C. Product Test Reports: For metal-framed skylights, for tests performed by a qualified testing agency.
 - D. Field quality-control reports.
 - E. Sample Warranties: For special warranties.
- 1.05 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For metal-framed skylights **[and] [metal-framed skylight operating system]** to include in maintenance manuals.
- 1.06 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of metal-framed skylights required for this Project.
 - B. Structural-Sealant Glazing: Comply with recommendations in ASTM C1401, "Guide for Structural Sealant Glazing," for joint design and quality-control procedures.

1. Joint designs are reviewed and approved by structural-sealant manufacturer.
 2. Quality-control program development and reporting comply with ASTM C1401 recommendations for material qualification procedures, preconstruction sealant-testing program, and procedures and intervals for fabrication and installation reviews and checks.
 3. Perform manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockup of typical metal-framed skylights as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal framed skylights that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals [**metal finishes,**] and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage.
 2. Warranty Period: [**Two**] [**Five**] [**10**] <Insert number> years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: [**Five**] [**10**] [**20**] <Insert number> years from date of Substantial Completion.

- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: **[Five] [10]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-framed skylights.
- B. Structural Loads: **[As indicated on Drawings]** <Insert loads>.
- C. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Glazing Plane: Limited to **[edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite]** **[1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans more than 13 feet 6 inches]** <Insert deflection limit> or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to **[L/360 of clear span or 1/8 inch, whichever is smaller]** **[amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch]** <Insert deflection limit>.
- D. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.
- E. Structural-Test Performance: Metal-framed skylights tested in accordance with ASTM E330, as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified deflection limits.
 2. When tested at **[150]** <Insert number> percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding **[0.2]** <Insert number> percent of span.
 3. Test Durations: As required by design wind velocity, but not less than **[10]** <Insert number> seconds.

- F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone **[1] [2] [3] [4]** for **[basic] [enhanced]** protection.
1. Large-Missile Test: For glazing located within **[30 feet]** <Insert dimension> of grade.
 2. Small-Missile Test: For glazing located between 30 feet and **[60 feet]** <Insert dimension> above grade.
- G. Air Leakage: Metal-framed skylights with maximum air leakage through fixed glazing and framing areas of **[0.06 cfm/sq. ft.]** <Insert value> of when tested in accordance with ASTM E283 at a minimum static-air-pressure difference of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.]** <Insert value>.
- H. Water Penetration under Static Pressure: Metal-framed skylights that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.]** <Insert value>.
- I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.
- J. Condensation Resistance: Metal-framed skylights with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than **[45] [53]** <Insert number> when tested in accordance with AAMA 1503.
1. Haze Factor: Greater than 90 percent when tested in accordance with ASTM D1003.
- K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant occurs before adhesive failure.
- L. Energy Performance: Provide metal-framed skylights with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below **[and certified and labeled according to NFRC]:**
1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas have U-factor of not more than **[0.80 Btu/sq. ft. x h x deg F] [0.65 Btu/sq. ft. x h x deg F]** <Insert value> as determined in accordance with NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas have a solar heat gain coefficient of no greater than **[0.6] [0.7]** <Insert value> as determined in accordance with NFRC 200.
- M. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 2.02 METAL-FRAMED SKYLIGHTS
- A. Metal-Framed Skylights: Glazed skylight assemblies supported by aluminum framing.

- B. Aluminum Framing Systems: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
- C. Aluminum: Alloy and temper as recommended in writing by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
 - 4. Structural Profiles: ASTM B308/B308M.
- D. Operable Systems: Equip operable metal-framed skylights with manufacturer's standard hinges, chain-driven operating hardware, and weather-sealing gaskets.
 - 1. Manual Operator: Manufacturer's standard, rotary-crank extension device.
 - a. Pole Operator: [Manual, **60 inches** long] [Manual, telescoping to **144 inches**] [Rechargeable-motor, power-driven type, telescoping to **144 inches**] <Insert requirements>.
 - 2. Motor Operator: Manufacturer's standard electronic control, including switch, transformer, low-voltage motor, cover, and mounting hardware.
 - a. Provide motor of size and capacity recommended by metal-framed skylight manufacturer to suit metal-framed skylight indicated.
 - b. Rain Sensors: Provide rain sensor that automatically closes operable unit when water is detected.
 - c. Remote Control: Provide motor operator with portable remote-control device.
- E. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 - 1. Include snap-on aluminum trim that conceals fasteners.
- F. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
- G. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. At pressure caps, use ASTM A193/A193M stainless steel screws.
 - 2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 3. Reinforce members as required to receive fastener threads.
 - 4. Use exposed fasteners with countersunk Phillips screw heads [, finished to match framing system] [, fabricated from Series 300 stainless steel].
- H. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- I. Anchor Bolts: ASTM A307, Grade A, galvanized steel.

- J. Concealed Flashing: [Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials] [Dead-soft, **0.018-inch**- thick stainless steel, ASTM A240/A240M of type recommended in writing by manufacturer].
- K. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than **[0.030 inch] [0.040 inch] [0.060 inch] <Insert dimension>** thick.
- L. Framing Sealants: As [recommended in writing by manufacturer.] [specified in Section 079200 "Joint Sealants."]
- M. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.03 GLAZING

- A. Glazing: As specified in [Section 088000 "Glazing."]
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Spacers and Setting Blocks: [Manufacturer's standard elastomeric types.] [As specified in Section 088000 "Glazing."]
- D. Glazing Sealants: As recommended in writing by manufacturer.
- E. Structural Glazing Sealants:
 - 1. Structural Sealant: ASTM C1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in metal-framed skylights indicated.
 - a. Color: [Black] [Gray] [As selected by Architect from manufacturer's full range].
 - 2. Weatherseal Sealant: ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.
 - a. Color: Matching structural sealant.
 - 3. Bond-Breaker Tape: [Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion] <Insert requirements>.

2.04 FABRICATION

- A. Where practical, fit and assemble metal-framed skylights in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Fabricate aluminum components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Internal guttering systems or other means to drain water passing joints and moisture migrating within skylight to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.

5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
- C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
 - D. Reinforce aluminum components as required to receive fastener threads.
 - E. Factory-Glazed, Metal-Framed Skylights:
 1. Factory install glazing to comply with requirements in **[Section 088000 "Glazing."]**
 - F. Structural-Sealant-Glazed, Metal-Framed Skylights: Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 - G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.
- 2.05 ALUMINUM FINISHES
- A. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm]** **[AA-M12C22A31, Class II, 0.010 mm]** or thicker.
 - B. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm]** **[AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
 1. Color: **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]** **<Insert color>**.
 - C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color and gloss>**.
 - D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color and gloss>**.
 - E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- 2.06 SOURCE QUALITY CONTROL
- A. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Comply with manufacturer's written instructions.

1. Do not install damaged components.
 2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 3. Rigidly secure nonmovement joints.
 4. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 5. Seal joints watertight unless otherwise indicated.
- B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with protective coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
- D. Install components to drain water passing joints, and moisture migrating within skylight to exterior.
- E. Install components plumb and true in alignment with established lines and elevations.
- F. Glazing: Install glazing as specified in **[Section 088000 "Glazing."]**
- G. Structural-Sealant Glazing:
1. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 2. Install weatherseal sealant according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.
- H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:
1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
 2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet but no greater than 1/2 inch over total length.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
1. Water-Spray Test: Before installation of interior finishes has begun, skylights are tested in accordance with AAMA 501.2 and do not evidence water penetration.
 2. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas are tested in accordance with ASTM E1105.
 - a. Test Procedures: Test under **[uniform] [and] [cyclic]** static-air pressure.
 - b. Static-Air-Pressure Difference: **<Insert pressure>**.
 - c. Water Penetration: None.

3. Structural-Sealant Compatibility and Adhesion: Structural sealant is tested in accordance with ASTM C1401.
 - a. Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C1401, Appendix X2, is used.
 - 1) A minimum of **[one] [two] <Insert number>** area(s) on each skylight face is tested.
 - 2) Repair installation areas damaged by testing.
 4. Structural-Sealant Glazing Inspection: After installation of metal-framed skylights is complete, structural-sealant glazing is inspected and evaluated in accordance with ASTM C1401 recommendations for quality-control procedures.
- B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
 - C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - D. Prepare test and inspection reports.

3.04 CLEANING AND PROTECTION

- A. Clean exposed surfaces immediately after installing skylights. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- B. Remove and replace **[glass] [plastic glazing]** that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect skylights from contact with contaminating substances resulting from construction operations. If contaminating substances do contact skylight surfaces, remove contaminants immediately according to manufacturer's written instructions.
- D. Metal-Framed Skylight Operating System: Clean and lubricate joints and hardware. Adjust for proper operation.

3.05 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain metal-framed skylight operating system.

END OF SECTION

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SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Door hardware.
- B. Thresholds, weather seals and smoke seals.
- C. Electrified door hardware.
- D. Scope of Work in this Section: Provide door hardware necessary to complete work. Hardware items not specifically specified or identified are to be provided of type and quality suitable to the service required and comparable to other hardware, and at no additional cost to Owner.

1.02 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Provide templates to:
 - 1. Section 08 11 13 for door and frame preparation.
 - 2. Section 08 11 16 for door and frame preparation.
 - 3. Section 08 14 16 for door preparation.
 - 4. Section 08 41 13 for door and frame preparation.
 - 5. Section 08 41 26 for door and frame preparation.
 - 6. Division 32 (Gates) for gate and frame preparation.

1.03 RELATED WORK

- A. Division 3-Concrete – Core Drilling for Stop Anchors
- B. Section 08 11 13-Hollow Metal Doors and Frames.
- C. Section 08 11 16-Aluminum Doors and Frames.
- D. Section 08 14 16-Flush Wood Doors.
- E. Section 08 33 13-Overhead Coiling Counter Doors.
- F. Section 08 33 16-Overhead Coiling Counter Grilles
- G. Section 08 33 23-Overhead Coiling Doors.
- H. Section 08 33 26-Overhead Coiling Grilles.
- I. Section 08 41 13-Aluminum Framed Entrance and Storefront.
- J. Section 08 41 26-All Glass Entrance and Storefront.
- K. Section 08 42 29-Sliding Automatic Entrances.

- L. Section 08 71 13-Automatic Swing Door Operators.
- M. Section 09 90 00-Painting.
- N. Division 26-Electrical.
- O. Division 28-Electronic Safety and Security.
- P. Division 32-Exterior Improvements (Gates).

1.04 REFERENCES

- A. Steel Door Institute (SDI) standards as specified.
- B. Architectural Woodwork Institute (AWI) as specified.
- C. California Building Code (CBC), permit edition.
- D. California Referenced Standards Code (CRSC).
- E. Americans with Disabilities Act (ADA) of 2010 ADA Standards.
- F. Underwriters Laboratories Inc. standards as specified.
- G. National Fire Protection (NFPA) standards as specified.

1.05 QUALITY ASSURANCE

- A. Hardware Supplier: Provide hardware from company specializing in supplying institutional door hardware with five years' experience and approved by specified hardware manufacturers as a factory direct supplier.
- B. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) or equivalent to prepare submittal required by this section.
- C. Hardware Consultant: All door hardware specifications, designs and submittals shall be made by an independent hardware consultant/contractor with a minimum of five years of direct experience doing similar work in the door hardware industry.

1.06 REGULATORY REQUIREMENTS

- A. Conform to CBC "Means of Egress" requirements.
- B. Conform to UL10C requirements applicable to positive pressure fire rated doors and frames. Provide all necessary hardware for complete fire labeled opening including anti-friction hinges, latching hardware, non-flaming fluid closers, smoke seals and intumescent hot seals.
- C. Conform to CRSC Standard 12-7-4 requirements applicable to fire rated doors and frames.
- D. Conform to applicable requirements of the Americans with Disabilities Act of 1990 regarding accessibility requirements for door and entrance hardware.
- E. Conform to applicable requirements of California Building Code regarding exiting and accessibility requirements for door and entrance hardware.
- F. All hardware shall meet the requirements of CBC Chapter 11B.

1.07 SUBMITTALS

- A. Submit schedule and product data under provisions of Division 1.
- B. Submit schedule with date of field survey of existing doors, frames, and hardware, along with any noted conflicts, otherwise schedule will be rejected.
- C. Provide five (5) copies of vertical format hardware schedule showing each application including door index, headings, hardware sets, door number and location, door and frame size and material, door and hardware handing, degrees of opening, quantity required, part numbers and finish of each item. For exterior doors, provide threshold shop drawings submittals with cross section and floor plan dimensioned drawings showing floor, threshold, door bottom seal, door, and frame for Architect's review and approval.
 - 1. Projects with multiple buildings and/or multiple floor levels must be submitted so each building and/or floor level is not mixed with another starting with Building A, 1st floor etc.
 - 2. Architect's review of such schedule does not relieve the Contractor of providing hardware required for the work, whether or not such hardware was inadvertently omitted from this Section.
- D. Accompanying the schedules, provide two (2) manufacturer's brochures of each item scheduled, indicating function, finish, dimensions, and related features. No hardware schedule will be accepted for review without submission of such brochure package.
- E. Submit manufacturer's certificate of warranty with submittal; otherwise material will be rejected.
- F. When alternate manufacturers are proposed by contractor, provide two (2) brochures of proposed items two weeks prior of bid date.
- G. Submit only manufacturers specified as approved or alternate.
- H. Provide samples indicating hardware design and finish when required by Architect.

1.08 COORDINATION

- A. Coordinate work of this Section with other directly affected Sections involving manufacturers of any internal reinforcement for door hardware.
- B. In particular, coordinate door preparation in accordance with applicable regulatory and trade standards specified.
- C. Field Survey: For projects with existing doors, frames, and or hardware within the project scope, prior to submitting the hardware schedule submittal, conduct a door-by-door survey of all openings in project scope to confirm existing doors, frames, door hardware, and hardware preps. Notify Architect of any conflicts between existing conditions and specified hardware; recommend a solution.
- D. Review details and conditions prior to ordering hardware. When a door hand is changed during construction, coordinate and change hardware as necessary at no cost to the Owner.
- E. Coordinate aluminum frame head stop heights to be minimum 5/8" so that overhead stop cut outs are not visible when the door is closed.

1.09 OPERATIONS AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 1.

- B. Include data on operating hardware. Lubrication requirements and inspection procedures related to preventive maintenance.

1.10 KEYING CONFERENCE:

- A. In addition to Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Requirements for access control.
 5. Address for delivery of keys.

1.11 SOURCE LIMITATIONS:

- A. Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Package hardware items individually; label and identify packages with door opening code to match hardware schedule.

1.13 MAINTENANCE MATERIALS

- A. Provide special wrenches and tools applicable to each different or special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

1.14 WARRANTY

- A. Provide two year guarantee against defects on hardware, including electrical components, five years warranty for cylindrical locks, mortise locks and exit devices and ten year warranty for surface, floor concealed closers and continuous hinges.
- B. Submit guarantee on form provided in Documents.
- C. Submit manufacturer's certificate of warranty with submittal, otherwise material will be rejected.

PART 2 PRODUCTS - DOOR HARDWARE CRITERIA

2.01 MANUFACTURERS

Item	Manufacturer	Approved Alternates
Hinges:	(HAG)-Hager	Best, Ives, McKinney

Continuous Hinges:	(MAR)-Markar	ABH, Best, Ives, Select
Continuous Gear Hinges:	(SEL)-Select	None
Gate Hinge/Closer System:	(LOC)-Locinox	None
Floor Closers:	(RIX)-Rixson	None
Pivots:	(ABH)-ABH Mfg.	Rixson
Power Transfers:	(VON)-Von Duprin	None
Armored Door Loops:	(KED)-Keedex	None
Wire Harnesses:	(COM)-Command Access	Or Equal
Push/Pull Plates:	(TRM)-Trimco	Ives, Rockwood, Tice
Anti-Vandal Pulls:	(TRM)-Trimco	None
Pulls:	(ROC)-Rockwood	Ives, Tice, Trimco
Manual Flush Bolts:	(ABH)-ABH Mfg.	Ives, Rockwood, Trimco
Wood Door Automatic Flush Bolts:	(ABH)-ABH Mfg.	Rockwood
Metal Door Automatic Flush Bolts:	(ABH)-ABH Mfg.	Ives, Rockwood, Trimco
Cane Bolts:	(CRW)-Crown Industrial	Richards-Wilcox
Weldable Lock Boxes:	(KED)-Kedex	None
Locks and Latchsets:	MATCH CAMPUS STANDARD (VOLUME 1)	
Cylinders:	MATCH CAMPUS STANDARD (VOLUME 1)	
Custom Strikes:	(TIC)-Tice Industries	Or Equal
Lock Guards:	(D-J)-Don-Jo	Or Equal
Exit Devices:	MATCH CAMPUS STANDARD (VOLUME 1)	
Glass Door Exit Devices:	(CRL)-C.R. Laurence	Access Door, Assa Abloy Glass Solutions, Dorma Glas, Frameless Hardware Co., PRL Glass
Strike Support:	(TIC)-Tice Industries	Or Equal
Coordinators:	(ABH)-ABH Mfg.	Ives, Rockwood, Trimco
Surface Closers:	(MATCH CAMPUS STANDARD (VOLUME 1)	
H.D. Floor Stops:	(IVE)-Ives	Rockwood, Trimco
Floor Stops:	(TRM)-Trimco	Tice
Wall Stops:	(ROC)-Rockwood	Tice
H.D. Wall Stops:	(TRM)-Trimco	None
Overhead Stops:	(ABH)-ABH Mfg.	Rixson
Magnetic Holders:	(RIX)-Rixson	ABH, LCN
Armor, Kick, & Mop Plates:	(TRM)-Trimco	Ives, Rockwood
Adhesive Seals with 3M Tape:	(ZER)-Zero	Legacy
Door Sweeps:	(ZER)-Zero	Legacy
Door Sweeps:	(NGP)-National Guard	Legacy, Zero
Automatic Door Bottoms:	(ZER)-Zero	Legacy
Thresholds:	(PEM)-Pemko	Legacy, National Guard, Zero
Coat Hooks:	(TIC)-Tice Industries	Or Equal

2.02 HINGES & PIVOTS

- A. Field-verify installed hinges or pivots per Condition Code Schedule in this section or per Architectural Door Schedule condition codes and take the noted actions
- B. Unless noted otherwise, provide steel hinges, with finish as shown in schedule. Provide non-ferrous hinges at exterior doors.
- C. Provide hinges in accordance with following schedule:

1. Doors up to 4 feet high: 2 hinges.
 2. Doors 4 feet to 7 feet 5 inches high: 3 hinges minimum.
 3. Doors greater than 7 feet 5 inches high: 4 hinges.
 4. Doors up to 3 feet wide, standard weight: 4-1/2" x 4-1/2" hinges.
 5. Doors 3'6" wide to under 4'0" wide, standard weight: 5" x 4-1/2".
 6. Doors 4'0" wide, heavy weight: 5" x 4-1/2".
 7. Provide heavy-weight hinges where specified.
 8. At doors weighing 150 lbs. or more, furnish hinges with leaf height as recommended by the hinge manufacturer.
 9. At doors in aluminum frames: standard weight 4-1/2" x 4-1/2" hinges, or continuous hinges as scheduled.
- D. Unless otherwise noted or required, provide full mortise five-knuckle ball-bearing hinges, with non-rising loose pins.
- E. Provide set screw (NRP) type at key lockable outswing doors to prevent pin removal when door is in closed position. Provide security stud (SH) type at key lockable exterior outswing doors.
- F. Where necessary to maintain door clearance at jamb trim, frame conditions, door reveals and similar conditions, provide wide throw hinges as approved by the Architect.
- G. Continuous Hinges
1. Where piano-type hinges are scheduled, to be barrel-type of 14 gauge 304 stainless steel, 14 gauge 1012 cold-rolled steel or 6063-T5 aluminum material with stainless steel Teflon-coated pin. Provide with "medical bearings" to reduce noise and accumulation of dust.
 2. Hinge guard models to be furnished with Adjusta-screw fasteners.
 3. Provide with self-lubricating fiber-reinforced polymer bearings ("MB" option) for noise-free operation and resistance to dust and dirt accumulation.
- H. Provide with piano-type with welded end pins.
- I. Where necessary to maintain door clearance at jamb trim, frame conditions, door reveals and similar conditions, provide wide throw hinges as approved by the Architect. Provide wide throw hinges as required for doors swinging 180° into a room to avoid conflict between the door closer cover and the wall or frame.
- J. Provide with factory cut-outs for mortise hardware that must penetrate the hinge (e.g. concealed power transfer, etc.) where they occur.
- K. Provide mortar guard frame box by hinge manufacturer for electric hinges where not provided by frame manufacturer.
- 2.03 KEYING
- A. Keying to be tied into the campus grand mastered keyway system. Provide per Campus Standards (Volume 1). Contractor to coordinate with campus Locksmith to determine keying requirements and keyway.
1. Cut keys at manufacturer's factory, where permanent key records are maintained.
 2. Provide padlocks and miscellaneous locking hardware where specified.

3. Provide each cylinder or lock with three change keys (customer keys).
 4. Provide twelve submaster keys (floor master key) for each master key group.
 5. Provide twenty master keys per master, ten grandmaster keys per grandmaster, and five great grandmaster keys per great grandmaster. Provide twenty-five permanent control keys for project.
 6. Stamp master keys and grand master keys with a registry number. Do not stamp "Master" or letter "M".
 7. Stamp individual room keys with plain identification number. Do not indicate key cut.
 8. Provide all permanent cores with Concealed Key Control (CKC) marking identifying the key symbol on the core's side or back.
 9. Cut keys and stamp DO NOT DUPLICATE.
 10. Tag cylinders and keys to indicate intended location and to establish key control system.
 11. Convene a keying meeting to determine final keying with Supplier, Contractor, Architect and Owner's Representative.
 12. Ship all permanent cores, permanent keys, and key blanks via registered means directly from the lock factory to the Owner's representative.
 13. Finish: Indicated in Hardware Schedule.
- B. Construction Keying: Contractor to provide temporary keyed alike cores for all lockable doors and gates in scope with 50 construction master keys and 10 construction control keys for use during the construction period. Return construction cores for credit.
- C. Provide cylinder collars and spacers to match key cylinder finish for each locking device. Provide collar and spacers to ensure a tight, secure fit of the key cylinder to the locking device with no gaps or spaces.
- 2.04 LOCKSETS, LATCHSETS, AND STRIKES
- A. Unless noted otherwise in schedule, locksets, latchsets, cylinders and component parts shall be the products of single manufacturer.
- B. Provide strikes at locks with curved lip strike of sufficient length to protect trim and jamb. Each strike will include wrought strike box (similar to Tice Industries No. 1502). At outswing doors with overlapping astragals installed on the pull side, provide a flat strike with 7/8" lip-to-center dimension.
- C. Mortise Locks:
1. Lock Body shall include quick reversibility mechanism without removing lock body cover.
 2. Provide cast or forged levers only. Roses, where specified, shall be wrought. Escutcheons, where specified, shall be cast or forged.
- D. Unless noted otherwise, provide 2-3/4 inch backset.
- E. Lock Throw: Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
- F. Field-verify installed locks per Condition Code Schedule in this section or per Architectural Door Schedule condition codes and take the noted actions.

- G. Auto Flush Bolts: Minimum ½” throw latch bolts, fully automatic extending into top strike and dust proof strike at sill. Provide longer rods as necessary for doors exceeding 7’0” in height. Where auto flush bolts are specified as top bolts only with bottom fire bolt at wood pairs rated above 20-minutes, provide bottom auto flush bolt and dust proof strike (DCI 82 or approved equal) in lieu of specified bottom fire bolt. Provide type of auto flush bolt required by door material (metal or wood), regardless of type specified.

2.05 PANIC EXIT DEVICES

- A. Where specified, provide panic exit device with required UL labels. Where panic device is required on fire rated doors, provide UL label with supplementary marking on door and hardware indicating compliant fire exit hardware.
- B. Provide modern push-pad type, reversible exit devices. Provide exit device manufacturer’s shims as required to clear glass lite frames.
- C. Push-pad shall be mounted at a height of not less than 34 inches (864mm) nor more than 44 inches (1118mm) above floor. The unlatching force shall not exceed 5 pounds.
- D. Exit Devices shall comply with CRSC Standard 12-10-3 and CBC Chapter 10 requirements. Provide device width as recommended by the exit device manufacturer for the door width.
- E. Provide exit devices levers of design to match lock levers.

2.06 DOOR CLOSERS

- A. Surface mounted closers to be full rack and pinion type with cast shell.
 - 1. Provide drop brackets, mortise shoes, and long arms as required. Provide 5th hole spacers where parallel arm shoes are mounted to narrow frame stops.
 - 2. Provide with drop plates where required to fit narrow top rails.
 - 3. Provide all closers with metal covers.
 - 4. Provide non-handed door closers with multi-sized springs, with separate adjustable valves for latch, sweep speed, and backcheck.
 - 5. Template and adjust closers per manufacturer’s recommendations and to meet accessibility requirements.
 - 6. Where regular arm closers are specified at doors that must swing past 120° and LCN 4040XP closers are used, revise closer to LCN 4040XPT-Series (top jamb) x 4040XPTJ-18 plate and provide minimum 4-1/2” wide hinges.
 - 7. Where used in conjunction with an overhead stop, provide special template, special arms, back plates, and other items as needed to allow the closer to be installed without conflicting with the overhead stop.

2.07 MAGNETIC HOLDERS

- A. Provide magnetic holders with tri-volts coils only.
- B. Provide assemblies consisting of an armature contact plate with adjustable mounting pivot.
- C. Use extensions as necessary to align door at parallel with wall.

2.08 PROTECTIVE PLATES

- A. Provide stainless steel kick, mop, and armor plates as scheduled, with all edges beveled. Where armor plates are specified at rated doors, provide with U.L. listing. Provide with all four edges heavy-beveled. Provide with countersunk fastener holes and oval-head countersunk screws.

2.09 STOPS

- A. Provide a floor or wall stop at every door.
- B. Provide carpet risers for floor stops where required.
- C. Where specified floor or wall stop would present a pedestrian hazard or cannot be used, furnish heavy-duty overhead concealed stop with stop degree adjustable in door track. Floor stops must impact the door no greater than 4" from the leading edge and be installed no more than 4" from an adjacent wall or pillar.
- D. Template overhead stops for maximum available swing.

2.10 SILENCERS

- A. Provide silencers at hollow metal or wood door frames that are without seals in quantities as follows:
 - 1. Single Doors: 3 silencers
 - 2. Pairs: 4 silencers

2.11 SEALS

- A. Provide seals complete with retainers, fasteners and trim.
- B. Provide UL listed seals at rated openings.
- C. Provide UL listed intumescent hot seal at fire rated wood doors when doors are not being furnish with intumescent hot seal.
- D. Unless noted otherwise, furnish fastener-applied silicone or neoprene seals at door jamb and head conditions. Use of vinyl seal prohibited.
- E. Where flat bar head seals are specified to accommodate hardware mounted to the underside of the frame stop, furnish factory-cut as required for frame stops narrower than the standard seal width.
- F. Where specified, furnish solid neoprene seals complying with MilSpec R6855, Class II, Grade 40.
- G. At doors in aluminum frames, omit frame seals. Frame seals will be provided by aluminum frame section.
- H. Where adhesive frame seals are scheduled, provide only type with genuine 3M adhesive tape for superior adhesion.
- I. Provide automatic door bottoms with the below features:
 - 1. Automatic door bottom fastened to door with screws from underneath door.
 - 2. Door edge mounting plates that allow the automatic door bottom mechanism to be removed for service or replacement without de-mounting the door from the frame.

- J. Where frame seals, astragals, or door bottoms are not specified at exterior hollow metal doors, provide weather seals as below:
1. Outswing door frame seals: Pemko 2891AS x CSK SCREWS.
 2. Inswing door frame seals: Pemko 332CS.
 3. Meeting stile astragals for pairs with panic hardware: Pemko 351C x 351CP.
 4. Overlapping astragals for pairs with locksets and auto flush bolts: Pemko 357SP x TB x SPECIAL HOLE PATTERN TO AVOID CONFLICT WITH LOCK AND AUTO FLUSH BOLTS x S88BL.
 5. Door bottoms: National Guard Products 200NA.

2.12 THRESHOLDS

- A. General: Except as otherwise indicated furnish standard metal threshold unit of type, size and profile as shown or scheduled. Where required by fire code, furnish appropriate model thresholds at openings where combustible floor material extends through the door opening. Provide threshold as indicated in details. Provide ¼-20 stainless steel fasteners with combo anchors.
- B. Thresholds must comply with the requirements of ADA and ANSI-117.1 and CBC Chapter 11B.
- C. Provide thresholds with aluminum composite filler where so specified for increased strength.

2.13 FINISHES

- A. Finishes are identified in Schedule at end of this Section.
- B. Where finish not shown, match finish of lockset.
- C. Where finish is noted in the hardware schedule as "TBD", request finish selection from the Architect and provide the selected finish.
- D. Provide fasteners matching in finish, base material and color.

2.14 FASTENERS

- A. Fasteners: Provide hardware manufacture to conform to publish templates, generally prepared for machine screws installation.
- B. Install hardware with manufacturer supplied screws for each item.
- C. Provide screws for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
- D. Provide concealed fasteners for hardware units which are exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners.
- E. Provide ¼-20 stainless steel machine screws and combo anchors for all thresholds.

2.15 ELECTRICAL DRAWINGS

- A. Provide custom point-to-point wiring diagram for each electric hardware application.
- B. Provide custom electric hardware elevation riser diagram for each hardware application.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings, instructed by the manufacturer.
- B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

- A. A QUALIFIED MECHANIC skilled in the application of institutional grade builder's hardware shall install hardware.
- B. Install hardware in accordance with manufacturer's instructions and requirements of SDI, ANSI/NFPA 80, AWI, and BHMA. Select applicable standard based on door function, type and regulatory criteria.
- C. Install hardware in accordance with NFPA 80 in fire labeled doors.
- D. Where door is designated as receiving new hardware, package and label hardware by type and function, and deliver to Owner.
- E. Predrill pilot holes in wood for screws. Drill and tap for surface mounted hardware on metal. Set hinge leaf snug and flat in mortises, turn screws to flat seat [do not drive].
- F. Mount surface closers on side of door away from corridor, inside rooms or in stairs. Install regular or parallel rigid arm closers as required.
- G. Provide ADEQUATE BACKING in stud partitions for the attachment of all respective finish hardware.
- H. Floor mounted door stops are to be installed at maximum of four inches from the face of the wall or partition.
- I. Install thresholds in full bed of sealant at front and side edges.

3.03 INSTALL HARDWARE USING TEMPLATES PROVIDED BY HARDWARE ITEM MANUFACTURER

- A. Prior to finishing door, fit hardware to door, utilizing fasteners and templates as specified.
- B. Remove hardware, carefully label and store. Where door exists and is designated to receive new finish, remove existing hardware.
- C. Re-install after door finish is complete

3.04 UNLESS NOTED OTHERWISE OR SHOWN ON DRAWINGS, MOUNT HARDWARE IN ACCORDANCE WITH THE FOLLOWING CRITERIA:

- A. Latchset and Lockset handle: 38 inches above finish floor. Verify manufacturer's template with door design.
- B. Glass locks: 40 inches above finish floor to center line. Verify manufacturer's template with door design.

- C. Auxiliary Locks: 40 inches to center line.
 - D. Panic Devices: 40 inches above floor; at storefront doors, aligned with center muntin on adjacent window wall. Verify manufacturer's template with door design.
 - E. Push and Pull Plates: 44 inches to center line.
 - F. Door Pulls: 40 inches above finish floor to center line.
- 3.05 ADJUST CLOSER OPERATING EFFORT CONFORM TO CALIFORNIA BUILDING CODE CHAPTER 11B.
- A. Exterior and Interior Doors: 5.0 pounds force. At exterior doors that lead into the same interior space a nearby exterior automatic door, 8.5 pounds force.
 - B. Fire Rated Doors: Verify with AHJ (Authority Having Jurisdiction) not to exceed 15.0 pounds force.
- 3.06 ADJUST CLOSER DELAY AND OPERATING SPEEDS TO COMPLY WITH REQUIREMENTS OF CALIFORNIA BUILDING CODE CHAPTER 11B.
- A. The sweep period of the door closers shall be adjusted so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch.
 - B. At non-rated interior and exterior door with closers, the door shall be able to open with no more than 5 lbs. opening force (or 8.5 lbs. per 3.5 A.) and still latch under balanced air pressure. Doors with closers shall be tested prior to closers being installed; doors shall be adjusted for no more than one-half pound force friction and ease of latching prior to closers being installed.
 - C. Closer Certification: Provide written certification, signed by door closer representative, stating closers were inspected and installed in accordance with specified opening force and delay requirements.
- 3.07 CLEAN AND ADJUST
- A. At completion, all hardware shall be left clean and free from disfigurement. Contractor shall make a final adjustment to all door closers and other items of hardware. Where hardware is found defective, repair, replace, or otherwise correct as directed.
 - B. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Adjust hardware so that moving parts operate freely, without bind, or excessive play. Hardware shall be free of paint, corrosion, or damage of any kind.
- 3.08 POST-INSTALLATION INSPECTION
- A. Provide written certification, signed by the hardware manufacturer representative, stating the locks, panics, and door closers were inspected and installed in accordance with specified operational requirements.

END OF SECTION

LACCD DOOR HARDWARE STANDARDS MATRIX

Finish Hardware Technology

April 8, 2024

ITEMS COMMON TO ALL LACCD CAMPUSES			
Item	Basis-of-Design Product(s)	Approved Equals	Notes
Butt Hinges	Hager full mortise 5-knuckle ball-bearing type. <ul style="list-style-type: none"> • BB1279 • BB1191 • BB1168 • BB1199 	Best Ives McKinney	<ol style="list-style-type: none"> 1) Non-removable pins at lockable outswing doors. 2) Non-ferrous at exterior doors or in wet areas (e.g., toilet rooms). 3) Electrified for concealed power/monitoring of electric locks or panic/fire exit devices. Molex-type connectors. Minimum 2 wires to be 18 ga. at electrified lock/unlock function; balance quantity as needed in thinner gage. 4) Swing-clear or wide throw as needed to suit conditions or meet code requirements. If electrification is required, provide suitable separate power transfer device.
Continuous Gear Hinges	Select SL11HD	None	<ol style="list-style-type: none"> 1) Typical use: Framed aluminum storefront doors. 2) Electrified for concealed power/monitoring of electric locks or panic/fire exit devices. Molex-type connectors. Minimum 2 wires to be 18 ga. at electrified lock/unlock function; balance quantity as needed in thinner gage. Swing-open access panels in hinge that does not separate main gear channel. 3) Swing-clear or wide throw as needed to suit conditions or meet code requirements. If electrification is required, provide suitable separate power transfer device.
Pin-and-Barrel Hinges	Markar stainless steel pin-and-barrel	ABH Mfg. Best Select	<ol style="list-style-type: none"> 1) Typical use: High frequency exterior hollow metal doors. 2) Electrified for concealed power/monitoring of electric locks or panic/fire exit devices. Molex-type connectors. Minimum 2 wires to be 18 ga. at electrified lock/unlock function; balance quantity as needed in thinner gage. Swing-open access panels in hinge that does not separate hinge barrel. 3) Swing-clear or wide throw as needed to suit conditions or meet code requirements. If electrification is required, provide suitable separate power transfer device.
Pivots	ABH Manufacturing (center-hung and offset-hung)	Ives, Rixson	<ol style="list-style-type: none"> 1) Electrified for concealed power/monitoring of electric locks or panic/fire exit devices. Molex-type connectors. Minimum 2 wires to be 18 ga. at electrified lock/unlock function; balance quantity as needed in thinner gage. Swing-open access panels in hinge that does not separate hinge barrel.
Wire Harnesses	Command Access Molex Connector Type	Allegion, Best, McKinney	
Flush Bolts	ABH Manufacturing	Rockwood	
Astragals	Pemko	Legacy, National Guard, Zero	
Architectural Door Pulls	Rockwood	Ives, Tice, Trimco	1-1/4" diameter pulls
Anti-Vandal Door Pulls	Trimco 1096HASP, 1097HASP	None	

ITEMS COMMON TO ALL LACCD CAMPUSES			
Item	Basis-of-Design Product(s)	Approved Equals	Notes
Kick, Mop, and Armor Plates	Trimco	Ives, Rockwood, Trimco	Typically 0.062-0.064" thick. 0.125" thick for armor plates at non-rated cart traffic doors. 0.050" thick for armor plates at fire-rated cart traffic doors.
Heavy-duty Floor Stops	Ives	Rockwood, Tice, Trimco	
Standard-duty Floor Stops	Trimco 7280HD	Tice 7085-1.5	
Wall Stops	Rockwood RM860	Trimco 1278CX	
Overhead Stops	ABH Manufacturing	Rixson	Adjustable for degree of stop in door track
Thresholds	Pemko	Legacy, National Guard, Zero	
Automatic Door Bottoms	Zero 364-PL-Z49	Legacy	Removable through hinge edge of door for easy maintenance
Door Sweeps	NGP 200NA	Legacy, Zero	
Door Sweep/Drips	Zero 8197AA	Legacy	
Fastener-Applied Head/Jamb Seals	Pemko 2891AS CSK	Legacy, National Guard, Zero	
Adhesive Head/Jamb Seals	Zero 488S	Legacy	Must have genuine 3M tape

ITEMS DIFFERENTIATED BY CAMPUS										
Item	Los Angeles Valley College	All LACCD Campuses Other than LAVC	East Los Angeles College	Los Angeles City College	Los Angeles Harbor College	Los Angeles Mission College	Los Angeles Pierce College	Los Angeles Southwest College	Los Angeles Trade Tech Collage	West Los Angeles College
Mortise Locks	Sargent 8200-Series WTL 630	Schlage L9000-Series 06N 630								
Panic / Fire Exit Hardware	Sargent 5CH-43-8800-Series x 522 630	Von Duprin AX-PA-98-Series 630								
Surface Closers	Sargent 351-Series	LCN 4040XP-Series 689								
Key System	Sargent Signature LFIC		Schlage Everest 29 R SFIC, 7-pin	Schlage Everest Primus LFIC (Level 9G)	Schlage Everest R SFIC, 7-pin	Best SFIC, 7-pin	Best SFIC, 7-pin	Best Peaks SFIC, 7-pin	Best SFIC, 7-pin	Best SFIC, 7-pin

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SECTION 08 71 13

AUTOMATIC SWING DOOR OPERATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

1.02 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

- A. This Section includes the following types of automatic door operators:
- B. Exterior and interior automatic swing door operators, low energy, with concealed-in-ground, overhead concealed, or surface mounting per Door Schedule and automatic door operator equipment schedule.
- C. Automatic door operators shall be configured for doors as follows:
 - 1. Simultaneous pairs out swing (available for independent operation).
 - 2. Single doors, inswing or outswing.

1.04 RELATED SECTIONS

- A. Section 08 71 00 Door Hardware for hardware to the extent not specified in this Section.
- B. Division 26 Sections for electrical connections including conduit and wiring for automatic door operators.
- C. Division 28 Electronic Safety and Security for Access control coordination.

1.05 REFERENCES

- A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
- B. Underwriters Laboratories (UL):
 - 1. UL 325 – Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.
 - 2. UL 228 – Standard for Automatic Closing Devices.
- C. American National Standards Institute (ANSI)/Builders' Hardware Manufacturers Association (BHMA):
 - 1. ANSI/BHMA A156.19: Standard for Power Assist and Low Energy Power Operated Doors.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - E. American Association of Automatic Door Manufacturers (AAADM):
 - F. National Fire Protection Association (NFPA):
 1. NFPA 101 – Life Safety Code.
 2. NFPA 70 – National Electric Code.
 - G. CBC: California Building Code (permit edition)
 - H. California Department of Forestry and Fire Protection, Office of the State Fire Marshall.
 - I. International Standards Organization (ISO):
 1. ISO 9001 - Standard for Manufacturing Quality Management Systems
 - J. National Association of Architectural Metal Manufacturers (NAAMM):
 1. Metal Finishes Manual for Architectural and Metal Products.
 - K. American Architectural Manufacturers Association (AAMA):
 1. AAMA 607.1 - Clear Anodic Finishes for Architectural Aluminum.
 2. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum.
- 1.06 DEFINITIONS
- A. Activation Device: Device that, when actuated, sends an electrical signal to the door operator to open the door.
- 1.07 PERFORMANCE REQUIREMENTS
- 1.08 Provide automatic door operators capable of withstanding structural loads and thermal movements based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
- 1.09 Operating Range: Minus 30 deg F (29 deg C) to 130 deg F (54 deg C).
- 1.10 Opening-Force Requirements for Egress Doors: In the event power failure to the operator, swinging automatic entrance doors shall open with a manual force, not to exceed 30 lbf (133 N) applied at 1" (25 mm) from the latch edge of the door.
- 1.11 Door Energy: The kinetic energy of a door in motion shall not exceed 1.25 lbs-ft (1.69 Nm).
- 1.12 Closing Time:
1. Doors shall be field adjusted to close from 90 degrees to 10 degrees in 3 seconds or longer.
 2. Doors shall be field adjusted to close from 10 degrees to fully closed in not less than 1.5 seconds.
- 1.13 SUBMITTALS
- 1.14 Submit listed submittals in accordance with Conditions of the Contract and Division 01 submittal procedures.

- 1.15 Shop Drawings: Include project-specific and door-specific plans, elevations, sections, details, hardware mounting heights, and attachments to other work. Indicate wiring for electrical supply. Provide custom point-to-point wiring diagrams showing connection to other work.
- 1.16 Color Samples for selection of factory-applied color finishes.
- 1.17 Closeout Submittals: Provide the following with project close-out documents.
1. Owner's Manual.
 2. Warranties.
- 1.18 QUALITY ASSURANCE
- 1.19 Supplier and Installer Qualifications: Manufacturer's authorized representative who is trained for installation and maintenance of units required for this Project.
- 1.20 Manufacturer Qualifications: A qualified manufacturer with a manufacturing facility certified under ISO 9001 and with company certificate issued by AAADM.
- 1.21 Certifications: Automatic door operators shall be certified by the manufacturer to meet performance design criteria in accordance with the following standards:
1. ANSI A156.19.
 2. NFPA 101.
 3. UL 228 Listed (Fire Door Operator).
 - a. Variance from local authority having jurisdiction required to allow automatic door operators to remain powered during a fire event to maintain stair pressurization in high rise construction.
 4. UL 325 Listed.
 5. ICBO (UBC Standard 10-1).
 6. California State Fire Marshall (CSFM) Listed.
 7. Source Limitations: Obtain automatic door operators through one source from a single manufacturer.
- 1.22 Product Options: Drawings indicate sizes, profiles, and dimensional requirements of automatic door assemblies and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- 1.23 Power Operated Door Standard: ANSI/BHMA A156.19.
- 1.24 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- 1.25 Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for swinging automatic entrance doors serving as a required means of egress.
- 1.26 PROJECT CONDITIONS
- 1.27 Field Measurements: General Contractor shall verify openings to receive automatic door operators by field measurements before fabrication and indicate measurements on Shop Drawings.

- 1.28 Mounting Surfaces: General Contractor shall verify all surfaces to be plumb, straight and secure; substrates to be of proper dimension and material.
- 1.29 Other trades: General Contractor Advise of any inadequate conditions or equipment.
- 1.30 COORDINATION
- 1.31 Templates: Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic door operators, safety sensors, activation switches, and control switches to comply with indicated requirements.
- 1.32 Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to, power supplies, and remote activation devices.
- 1.33 System Integration: Integrate automatic door operators with other systems as required for a complete working installation. Provide all connection wires and electric connection points with labels indicating use and function.
1. Provide electrical interface control capability for card reader or keypad operation of automatic door operators on doors with electric locking.
 2. Where required for proper operation, provide a time delay relay to signal automatic door operator to activate only after electric lock system is released.
- 1.34 WARRANTY
- 1.35 Automatic door operators shall be free of defects in material and workmanship for a period of five (5) years from the date of substantial completion.
- 1.36 During the warranty period the Owner shall engage a factory-trained technician to perform service and affect repairs. A safety inspection shall be performed after each adjustment or repair and a completed inspection form shall be submitted to the Owner.
- 1.37 During the warranty period all warranty work, including but not limited to emergency service, shall be performed during normal working hours and within one (1) business day of the service request.

PART 2 PRODUCTS

2.01 AUTOMATIC DOOR OPERATORS

- A. Manufacturers: ASSA Abloy Entrance Systems SW200i-Series or Horton 4100LE/4900LE-Series; surface-mounted, overhead concealed, or concealed-in-ground, as indicated in the Automatic Door Operator Equipment Schedule in this section. Provide for each leaf of each opening scheduled with an automatic door operator hardware set.

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Headers: 6063-T6.
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 3. Sheet and Plate: ASTM B 209.

- B. Sealants and Joint Fillers: Refer to Division 7 Section "Interior Joint Sealants".

2.03 COMPONENTS

- A. Surface-mounted Operator Enclosures: Provide for the full-width of the opening, length to match the frame head. Provide combined enclosures for pairs of doors.
- B. Door Arms: A combination of door arms and linkage shall provide positive control of door through entire swing; units shall permit use center pivot -hung doors. Center-pivoted overhead concealed units shall include "power arm" that will serve as the direct drive top pivot.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
- D. Signage: Provide signage in accordance with ANSI/BHMA A156.19.
- E. Threshold Assemblies at In-Ground Operators: Provide architectural grooved metal threshold assemblies by National Guard Products, Pemko, Zero, or Legacy of accessible profile approved by the Architect, aluminum material, to cover in-ground operators. Where these occur at banks of doors, provide continuous threshold assembly for non-automatic doors as well. All threshold assemblies to provide for easy access to in-ground operators. Provide with mitered (returned closed) ends. Provide with stainless steel 1/4-20 machine screws and minimum 2" long anchors.
- F. Cover Pans: Where finish floor material runs through opening at in-ground operators, provide cover pans as needed to hold finish floor material and conceal operators.
- G. Special Cement Cases: Provide special cement cases with special anchoring as required to suit slab conditions.

2.04 SWINGING DOOR OPERATORS

- A. Operator Type: Low energy; readily convertible to full energy; no tools required to change type.
 - 1. Mounting: Concealed-in-ground at all-glass doors, Surface mounted at hollow metal doors, aluminum storefront doors, and fire-rated steel-and-glass doors, unless noted otherwise per condition codes. Install inside room or on least-public side except where referenced otherwise in Section 087100.
 - a. Adjustable opening and closing speeds.
 - b. Adjustable opening and closing force.
 - c. Adjustable back-check.
 - d. Adjustable hold-open time between 0 and 30 seconds.
 - e. Reverse on obstruction.
 - f. Variable rate open/closed speed control.
 - g. Closed loop speed control with active braking and acceleration.
 - h. Variable obstruction recycle time delay.
 - i. When operators are provided in pairs, adjustable features are independently adjustable for each operator. Provide for independent opening.

2.05 ELECTRICAL CONTROLS

- A. Safety Search Circuitry: Provide system to recycle the swinging panels when an obstruction is encountered during the closing cycle. If an obstruction is detected, the system shall search for that object on the next closing cycle by reducing door closing speed prior to the previously encountered obstruction location, and will continue to close in check speed until doors are fully closed, at which time the doors will reset to normal speed. If obstruction is encountered again, the door will come to a full stop. The doors shall remain stopped until obstruction is removed and operate signal is given, resetting the door to normal operation.
- B. Control Switch: Automatic door operators shall be equipped with a Camden four position key switch to control the operation of the door. Control switch shall provide four modes of operation: On, Off, Exit (Night Mode), and Hold-Open. Assume Camden CM-180/24 for pricing purposes.
- C. Safety Sensing at Doors with Knowing Switch Activation: Provide BEA LZR-Flatscan 3D re-activation and stall sensors and both sides of each leaf. Push side sensor to sense when a person is in the doorway and signal the automatic door operator to re-activate until the doorway is clear. Pull-side sensor to sense when a person is in the doorway and signal the automatic door operator to stall until the doorway is clear. Installed with concealed wiring through power transfer unless noted otherwise.
- D. Time Delay Relays: Provide 2 each BEA Br3-X time delay relays per opening to coordinate electric unlatching and to facilitate REX signal splitting from interior touchless activation switch.
- E. Power Switch: Provide toggle switch for 120V power connection directly on top of operator enclosure for surface-mounted operators, on header face for overhead-concealed operators, or where directed by the Architect for concealed-in-floor operators.

2.06 ACTIVATION DEVICES

- A. Knowing Activation: Per Automatic Door Operator Equipment Schedule in this Section and as modified by condition codes scheduled in the Door Schedule.
 - 1. Vertical Actuation Bars: Wikk Industries.
 - 2. Touchless Activation Switches: BEA Sensors, or Camden Controls.
- B. Pedestals: Where shown in the Drawings and Door Schedules and as noted by the condition codes scheduled in the Door Schedule.
 - 1. Manufacturer: Wikk Industries.
 - 2. Provide of suitable height for all required vertical actuation bars, touchless activation switches, and card readers. Factory prep pedestals for electronic devices.
 - 3. Provide with sloped top.

2.07 FINISHES

- A. Provide operator enclosure and mounting plate in custom anodized finish to match door and frame finish.
- B. Provide arm assembly in custom powdercoated finish to match door and frame assembly.

2.08 AUTOMATIC DOOR OPERATOR EQUIPMENT SCHEDULE

Operator Type / Hardware Set	Activation	Safety Sensors	Other

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of swinging automatic entrance doors. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints.
- B. Mounting: Install automatic door operators/headers plumb and true in alignment with established lines and grades. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, arms and linkages level and true to location with anchorage for permanent support.
- C. Door Operators: Connect door operators to electrical power distribution system as specified in Division 26 Sections.
- D. Sealants: Comply with requirements specified in Division 7 Section "Joint Sealants" to provide weather tight installation.

3.03 FIELD QUALITY CONTROL

- A. Testing Services: Factory Trained Installer shall test and inspect each swinging automatic entrance door to determine compliance of installed systems with applicable ANSI standards.

3.04 ADJUSTING

- A. Adjust door operators, controls, and hardware for smooth and safe operation, for weather-tight closure, and complying with requirements in ANSI/BHMA A156.19 by AAADM Certified Technician.

3.05 CLEANING AND PROTECTION

- A. Clean surfaces promptly after installation. Remove excess sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

END OF SECTION

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SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glass products.
2. Laminated glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing tapes.
6. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 057313 "Glazed Decorative Metal Railings" for glazing in railings.
2. Section 084126 "All-Glass Entrances and Storefronts."
3. Section 084233 "Revolving Door Entrances" for glass in revolving door entrances.
4. Section 084423 "Structural-Sealant-Glazed Curtain Walls" for glazing sealants used in structural-sealant-glazed curtain walls.
5. Section 088113 "Decorative Glass Glazing."
6. Section 088300 "Mirrors."
7. Section 088733 "Glazing Surface Films – Anti-Graffiti".
8. Section 088813 "Fire-Rated Glazing."
9. Section 088853 "Security Glazing."

1.02 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.
- C. IBC: International Building Code.

- D. Interspace: Space between lites of an insulating-glass unit.

1.03 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of [glass product other than clear monolithic vision glass] [the following products]; 12 inches square.
 - 1. Tinted glass.
 - 2. Coated glass.
 - 3. Laminated glass.
 - 4. Insulating glass.
 - 5. Spandrel glass.
- C. Glazing Accessory Samples: For [sealants] [and] [colored spacers], in 12-inch lengths. [Install sealant Samples between two strips of material representative in color of adjoining framing system.]
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [manufacturers of fabricated glass units] [glass testing agency] [and] [sealant testing agency].
- B. Product Certificates: For glass.
- C. Product Test Reports: For **[fabricated glass]** [and] **[glazing sealants]**, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.07 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved [**and certified**] by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors [**and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in [Section 084113 "Aluminum-Framed Entrances and Storefronts"] [Section 085113 "Aluminum Windows"] [Section 084413 "Glazed Aluminum Curtain Walls"] <Insert Section number and title> to match glazing systems required for Project, including glazing methods.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.

3. Test no fewer than [**eight**] <Insert number> Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.

4. Schedule enough time for testing and analyzing results to prevent delaying the Work.

5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: [**10**] <Insert number> years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: [**Five**] [**10**] <Insert number> years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: [**10**] <Insert number> years from date of Substantial Completion.
- D. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.
 - 1. Warranty Period: [**Five**] [**10**] <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Glass: Obtain **[tinted]** **[and]** **[coated]** glass from single source from single manufacturer.
- B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
 - 1. Design Wind Pressures: [As indicated on Drawings] [Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings].
 - a. Wind Design Data: As indicated on Drawings.
 - b. Basic Wind Speed: **[85 mph]** **[90 mph]** **[100 mph]** **[110 mph]** <Insert value>.
 - c. Importance Factor: **[1.0]** <Insert factor>.
 - d. Exposure Category: **[B]** **[C]** **[D]**.
 - 2. Design Snow Loads: <Insert design snow load> [As indicated on Drawings].
 - 3. Probability of Breakage for Sloped Glazing: For glass sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
 - 4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
 - 5. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- D. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone **[1]** **[2]** **[3]** **[4]** for **[basic]** **[enhanced]** protection.
 - 1. Large-Missile Test: For glazing located within **[30 feet]** <Insert dimension> of grade.
 - 2. Small-Missile Test: For glazing located between 30 feet and **[60 feet]** <Insert dimension> above grade.

- E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. For monolithic-glass lites, properties are based on units with lites **[6 mm thick] [of thickness indicated]**.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
 - 5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
 - 6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.
- G. Acoustic Performance:
 - 1. Exterior Glazing: **[28] [33] [35] <Insert number>** OITC.
 - 2. Interior Glazing: **[35] [37] [41] <Insert number>** STC.

2.03 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: ["Laminated Glazing Reference Manual" and] "Glazing Manual."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of **[the SGCC] [the SGCC or another certification agency acceptable to authorities having jurisdiction] [or] [manufacturer]**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

- D. Thickness: Where glass thickness is indicated, it is a minimum. [Provide glass that complies with performance requirements and is not less than thickness indicated.]
1. Minimum Glass Thickness for Exterior Lites: [**6 mm**] <Insert thickness designation>.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass [**as needed to comply with "Performance Requirements" Article**]. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass [**as needed to comply with "Performance Requirements" Article**]. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.04 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent [**and SHGC of not less than 0.87**].
- C. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- E. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- F. Pyrolytic-Coated, Low-Maintenance Glass: Clear float glass with coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.
- G. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.
- H. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."
- I. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.
- J. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.
- K. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.05 LAMINATED GLASS

- A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Construction: Laminate glass with [**polyvinyl butyral interlayer**] [**ionoplast interlayer**] [**or**] [**cast-in-place and cured-transparent-resin interlayer**] to comply with interlayer manufacturer's written instructions.
 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 3. Interlayer Color: Clear unless otherwise indicated.
- B. Windborne-Debris-Impact-Resistant Laminated Glass: Comply with requirements specified above for laminated glass except laminate glass with [**one of**] the following to comply with interlayer manufacturer's written instructions:
1. Construction: Laminate glass with [polyvinyl butyral interlayer reinforced with polyethylene terephthalate film] [ionoplast interlayer] [or] [cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film] to comply with interlayer manufacturer's written instructions.
 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 3. Interlayer Color: Clear unless otherwise indicated.

2.06 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
1. Sealing System: Dual seal, with [manufacturer's standard] [polyisobutylene and polysulfide] [polyisobutylene and silicone] [polyisobutylene and hot-melt butyl] [polyisobutylene and polyurethane] <Insert description> primary and secondary sealants.
 2. Perimeter Spacer: [Manufacturer's standard spacer material and construction] [Aluminum with mill or clear anodic finish] [Aluminum with black, color anodic finish] [Aluminum with bronze, color anodic finish] [Aluminum with powdered metal paint finish in color selected by Architect] [Galvanized steel] [Stainless steel] [Polypropylene-covered stainless steel in color selected by Architect] [Thermally broken aluminum] [Nonmetallic laminate] [Nonmetallic tube] [Silicone with integral desiccant and vapor barrier] <Insert material>.
 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.07 GLAZING SEALANTS

- A. General:
1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Colors of Exposed Glazing Sealants: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range of industry colors].
- B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.
1. Applications: <Describe types of glazing applications where sealant is required>.
- C. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.
1. Applications: <Describe types of glazing applications where sealant is required>.
- D. Neutral-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.
1. Applications: <Describe types of glazing applications where sealant is required>.
- E. Acid-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.
1. Applications: <Describe types of glazing applications where sealant is required>.

2.08 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.09 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks:
 - 1. **[EPDM] [Silicone] <Insert type>** with Shore A durometer hardness of 85, plus or minus 5.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- D. Spacers:
 - 1. **[Neoprene] <Insert type>** blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- E. Edge Blocks:
 - 1. **[EPDM] [Silicone] <Insert type>** with Shore A durometer hardness per manufacturer's written instructions.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: [**120 deg F**, ambient; **180 deg F**, material surfaces] <Insert temperature change>.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.03 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch- minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.04 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.05 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.07 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.08 MONOLITHIC GLASS SCHEDULE

- A. Clear Glass Type <Insert drawing designation>: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
 - 1. Minimum Thickness: [**6 mm**] <Insert thickness>.
 - 2. Safety glazing required.
- B. Low-Iron Glass Type <Insert drawing designation>: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
 - 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 - 2. Minimum Thickness: [**6 mm**] <Insert thickness>.

3. Safety glazing required.
- C. Pyrolytic-Coated, Low-Maintenance Glass Type <Insert drawing designation>: Clear [annealed] [heat-strengthened] [fully tempered] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Minimum Thickness: [6 mm] <Insert thickness>.
 3. Safety glazing required.
- D. Tinted Glass Type <Insert drawing designation>: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 3. Minimum Thickness: [6 mm] <Insert thickness>.
 4. Winter Nighttime U-Factor: <Insert value> maximum.
 5. Summer Daytime U-Factor: <Insert value> maximum.
 6. Visible Light Transmittance: <Insert number> percent minimum.
 7. SHGC: <Insert value> maximum.
 8. Safety glazing required.
- E. Ceramic-Coated Vision Glass Type <Insert drawing designation>: [Heat-strengthened] [Fully tempered] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Glass: [Clear] [Low-iron] [Tinted] float glass.
 3. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 4. Ceramic Coating Color and Pattern: [As selected by Architect from manufacturer's full range] [Match Architect's samples] <Insert one manufacturer's color and pattern designation if matching is required> <Insert manufacturer's name; color and pattern designation>.
 5. Minimum Thickness: [6 mm] <Insert thickness>.
 6. Coating Location: Second surface.
 7. Winter Nighttime U-Factor: <Insert value> maximum.
 8. Summer Daytime U-Factor: <Insert value> maximum.
 9. Visible Light Transmittance: <Insert number> percent minimum.

10. SHGC: **<Insert value>** maximum.
 11. Safety glazing required.
- F. Reflective-Coated Vision Glass Type **<Insert drawing designation>**: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Kind CV (coated vision glass) [, except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than **6 feet** above the adjacent floor level or cannot be approached closer than **10 feet**].
 3. Coating Type: [Pyrolytic] [Sputter-coating (vacuum deposition process)].
 4. Coating Color: [Gold] [Pewter] [Silver] **<Insert color>**.
 5. Glass: [**Clear**] [**Tinted**] float glass.
 6. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] **<Insert color>**.
 7. Minimum Thickness: [**6 mm**] **<Insert thickness>**.
 8. Coating Location: [**First**] [**Second**] surface.
 9. Outdoor Visible Reflectance: **<Insert number>** percent maximum.
 10. Winter Nighttime U-Factor: **<Insert value>** maximum.
 11. Summer Daytime U-Factor: **<Insert value>** maximum.
 12. Visible Light Transmittance: **<Insert number>** percent minimum.
 13. SHGC: **<Insert value>** maximum.
 14. Low-Maintenance Coating: Pyrolytic coating on first surface.
 15. Safety glazing required.
- G. Ceramic-Coated Spandrel Glass Type **<Insert drawing designation>**: [**Heat-strengthened**] [**Fully tempered**] float glass.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Glass: [**Clear**] [**Low-iron**] [**Tinted**] float glass.
 3. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] **<Insert color>**.
 4. Coating Color: [As selected by Architect from manufacturer's full range] [Match Architect's samples] **<Insert one manufacturer's color designation if matching is required>** **<Insert manufacturer's name; color designation>**.
 5. Minimum Thickness: [**6 mm**] **<Insert thickness>**.
 6. Coating Location: Second surface.

7. Winter Nighttime U-Factor: **<Insert value>** maximum.
 8. Summer Daytime U-Factor: **<Insert value>** maximum.
 9. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.
- H. Silicone-Coated Spandrel Glass Type **<Insert drawing designation>**: **[Heat-strengthened]** **[Fully tempered]** float glass.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Glass: **[Clear]** **[Low-iron]** **[Tinted]** float glass.
 3. Tint Color: **[Blue]** **[Blue-green]** **[Bronze]** **[Green]** **[Gray]** **<Insert color>**.
 4. Coating Color: **[As selected by Architect from manufacturer's full range]** **[Match Architect's samples]** **<Insert one manufacturer's color designation if matching is required>** **<Insert manufacturer's name; color designation>**.
 5. Minimum Thickness: **[6 mm]** **<Insert thickness>**.
 6. Coating Location: Second surface.
 7. Winter Nighttime U-Factor: **<Insert value>** maximum.
 8. Summer Daytime U-Factor: **<Insert value>** maximum.
 9. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.
- I. Reflective-Coated Spandrel Glass Type **<Insert drawing designation>**: **[Heat-strengthened]** **[Fully tempered]** float glass.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Coating Type: **[Pyrolytic]** **[Sputter-coating (vacuum deposition process)]**.
 3. Coating Color: **[Gold]** **[Pewter]** **[Silver]** **<Insert color>**.
 4. Glass: **[Clear]** **[Low-iron]** **[Tinted]** float glass.
 5. Tint Color: **[Blue]** **[Blue-green]** **[Bronze]** **[Green]** **[Gray]** **<Insert color>**.
 6. Minimum Thickness: **[6 mm]** **<Insert thickness>**.
 7. Coating Location: **[First]** **[Second]** surface.
 8. Outdoor Visible Reflectance: **<Insert number>** percent maximum.
 9. Winter Nighttime U-Factor: **<Insert value>** maximum.
 10. Summer Daytime U-Factor: **<Insert value>** maximum.

11. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.
12. Factory apply manufacturer's standard opacifier of the following material to coated on second surface of lites, with resulting products complying with Specification No. 89-1-6 in NGA's "Engineering Standards Manual":
 - a. Manufacturer's standard opacifier material.
 - b. Polyester film laminated to glass with solvent-based adhesive.

3.09 LAMINATED GLASS SCHEDULE

- A. Clear Laminated Glass Type <Insert drawing designation>: Two plies of [annealed] [heat-strengthened] [fully tempered] [low-iron annealed] [low-iron heat-strengthened] [low-iron fully tempered] float glass.
 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Minimum Thickness of Each Glass Ply: [3 mm] [4 mm] [5 mm] [6 mm] [As indicated] <Insert thickness>.
 3. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].
 4. Safety glazing required.
- B. Laminated Tinted Glass Type <Insert drawing designation>: Two plies of [annealed] [heat-strengthened] [fully tempered] float glass with outer ply tinted and inner ply clear.
 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 3. Minimum Thickness of Each Glass Ply: [3 mm] [4 mm] [5 mm] [6 mm] [As indicated] <Insert thickness>.
 4. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].
 5. Winter Nighttime U-Factor: <Insert value> maximum.
 6. Summer Daytime U-Factor: <Insert value> maximum.
 7. Visible Light Transmittance: <Insert number> percent minimum.
 8. SGHC: <Insert value> maximum.
 9. Safety glazing required.
- C. Tinted Interlayer Laminated Glass Type <Insert drawing designation>: Two plies of clear [annealed] [heat-strengthened] [fully tempered] float glass and tinted interlayer.
 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 3. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 4. Interlayer Color: [Blue-green] [Bronze light] [Gray] <Insert color>.
 5. Winter Nighttime U-Factor: <Insert value> maximum.
 6. Summer Daytime U-Factor: <Insert value> maximum.
 7. Visible Light Transmittance: <Insert number> percent minimum.
 8. SGHC: <Insert value> maximum.
 9. Safety glazing required.
- D. Ceramic-Coated, Laminated Vision Glass Type <Insert drawing designation>: Two plies of [**heat-strengthened**] [**fully tempered**] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Outer Ply: [**Clear**] [**Low-iron**] [**Tinted**] float glass.
 3. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 4. Inner Ply: [**Clear**] [**Low-iron**] float glass.
 5. Ceramic Coating Color and Pattern: [As selected by Architect from manufacturer's full range] [Match Architect's samples] <Insert one manufacturer's color and pattern designation if matching is required> <Insert manufacturer's name; color and pattern designation>.
 6. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 7. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 8. Coating Location: [**Second**] [**Third**] [**Fourth**] surface.
 9. Winter Nighttime U-Factor: <Insert value> maximum.
 10. Summer Daytime U-Factor: <Insert value> maximum.
 11. Visible Light Transmittance: <Insert number> percent minimum.
 12. SGHC: <Insert value> maximum.
 13. Safety glazing required.
- E. Reflective-Coated, Laminated Vision Glass Type <Insert drawing designation>: Two plies of [**heat-strengthened**] [**fully tempered**] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Kind CV (coated vision glass) [, except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than **6 feet** above the adjacent floor level or cannot be approached closer than **10 feet**].
 3. Coating Type: [Pyrolytic] [Sputter-coating (vacuum deposition process)].
 4. Coating Color: [Gold] [Pewter] [Silver] <Insert color>.
 5. Outer Ply: [**Clear**] [**Tinted**] float glass.
 6. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 7. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 8. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 9. Coating Location: [**First**] [**Second**] [**Third**] surface.
 10. Outdoor Visible Reflectance: <Insert number> percent maximum.
 11. Winter Nighttime U-Factor: <Insert value> maximum.
 12. Summer Daytime U-Factor: <Insert value> maximum.
 13. Visible Light Transmittance: <Insert number> percent minimum.
 14. SGHC: <Insert value> maximum.
 15. Low-Maintenance Coating: Pyrolytic coating on first surface.
 16. Safety glazing required.
- F. Low-E-Coated, Laminated Vision Glass Type <Insert drawing designation>: Two plies of clear [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 3. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 4. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 5. Winter Nighttime U-Factor: <Insert value> maximum.
 6. Summer Daytime U-Factor: <Insert value> maximum.
 7. Visible Light Transmittance: <Insert number> percent minimum.
 8. SGHC: <Insert value> maximum.

9. Safety glazing required.

G. Reflective-Coated, Laminated Spandrel Glass Type <Insert drawing designation>: Two plies of [heat-strengthened] [fully tempered] float glass.

1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Coating Type: [Pyrolytic] [Sputter-coating (vacuum deposition process)].

3. Coating Color: [Gold] [Pewter] [Silver] <Insert color>.

4. Outer Ply: [Clear] [Tinted] float glass.

5. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.

6. Minimum Thickness of Each Glass Ply: [3 mm] [4 mm] [5 mm] [6 mm] [As indicated] <Insert thickness>.

7. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].

8. Coating Location: [First] [Second] [Third] surface.

9. Outdoor Visible Reflectance: <Insert number> percent maximum.

10. Winter Nighttime U-Factor: <Insert value> maximum.

11. Summer Daytime U-Factor: <Insert value> maximum.

3.10 INSULATING GLASS SCHEDULE

A. Clear Insulating Glass Type <Insert drawing designation>:

1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Overall Unit Thickness: [1 inch] [5/8 inch] <Insert dimension>.

3. Minimum Thickness of Each Glass Lite: [3 mm] [4 mm] [5 mm] [6 mm] <Insert thickness>.

4. Outdoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] float glass.

5. Interspace Content: [Air] [Argon].

6. Indoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] float glass.

7. Winter Nighttime U-Factor: <Insert value> maximum.

8. Summer Daytime U-Factor: <Insert value> maximum.

9. Safety glazing required.

B. Low-Iron Insulating Glass Type <Insert drawing designation>:

1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: Low-iron [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 5. Interspace Content: [**Air**] [**Argon**].
 6. Indoor Lite: Low-iron [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 7. Winter Nighttime U-Factor: <Insert value> maximum.
 8. Summer Daytime U-Factor: <Insert value> maximum.
 9. Safety glazing required.
- C. Pyrolytic-Coated, Low-Maintenance Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: [Cardinal Glass Industries; Neat] [Pilkington North America Inc.; Activ] <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 5. Interspace Content: [**Air**] [**Argon**].
 6. Indoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
 7. Winter Nighttime U-Factor: <Insert value> maximum.
 8. Summer Daytime U-Factor: <Insert value> maximum.
 9. Safety glazing required.
- D. Low-E-Coated, Clear Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] [Low-iron annealed] [Low-iron heat-strengthened] [Low-iron fully tempered] float glass.
 5. Interspace Content: [**Air**] [**Argon**].

6. Indoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] [Low-iron annealed] [Low-iron heat-strengthened] [Low-iron fully tempered] float glass.
 7. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 8. Winter Nighttime U-Factor: <Insert value> maximum.
 9. Summer Daytime U-Factor: <Insert value> maximum.
 10. Visible Light Transmittance: <Insert number> percent minimum.
 11. SGHC: <Insert value> maximum.
 12. Safety glazing required.
- E. Pyrolytic-Coated, Low-Maintenance, Low-E-Coated, Clear Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [1 inch] [5/8 inch] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [3 mm] [4 mm] [5 mm] [6 mm] <Insert thickness>.
 4. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [annealed] [heat-strengthened] [fully tempered] float glass.
 5. Interspace Content: [Air] [Argon].
 6. Indoor Lite: [Annealed] [Heat-strengthened] [Fully tempered] float glass.
 7. Low-E Coating: [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 8. Winter Nighttime U-Factor: <Insert value> maximum.
 9. Summer Daytime U-Factor: <Insert value> maximum.
 10. Visible Light Transmittance: <Insert number> percent minimum.
 11. SGHC: <Insert value> maximum.
 12. Safety glazing required.
- F. Tinted Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [1 inch] [5/8 inch] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [3 mm] [4 mm] [5 mm] [6 mm] <Insert thickness>.

4. Outdoor Lite: Tinted [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 5. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 6. Interspace Content: [**Air**] [**Argon**].
 7. Indoor Lite: Clear [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 8. Winter Nighttime U-Factor: <Insert value> maximum.
 9. Summer Daytime U-Factor: <Insert value> maximum.
 10. Visible Light Transmittance: <Insert number> percent minimum.
 11. SGHC: <Insert value> maximum.
 12. Safety glazing required.
- G. Low-E-Coated, Tinted Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 3. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: Tinted [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 5. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 6. Interspace Content: [**Air**] [**Argon**].
 7. Indoor Lite: Clear [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 8. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 9. Winter Nighttime U-Factor: <Insert value> maximum.
 10. Summer Daytime U-Factor: <Insert value> maximum.
 11. Visible Light Transmittance: <Insert number> percent minimum.
 12. SGHC: <Insert value> maximum.
 13. Safety glazing required.
- H. Ceramic-Coated, Insulating Vision Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.

2. Ceramic Coating Color and Pattern: [As selected by Architect from manufacturer's full range] [Match Architect's samples] <Insert one manufacturer's color and pattern designation if matching is required> <Insert manufacturer's name; color and pattern designation>.
 3. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 4. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 5. Outdoor Lite: [Clear heat-strengthened] [Clear fully tempered] [Low-iron heat-strengthened] [Low-iron fully tempered] [Tinted heat-strengthened] [Tinted fully tempered] float glass.
 6. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 7. Interspace Content: [**Air**] [**Argon**].
 8. Indoor Lite: [Clear heat-strengthened] [Clear fully tempered] [Low-iron annealed] [Low-iron heat-strengthened] [Low-iron fully tempered] float glass.
 9. Coating Location: [**Second**] [**Third**] [**Fourth**] surface.
 10. Winter Nighttime U-Factor: <Insert value> maximum.
 11. Summer Daytime U-Factor: <Insert value> maximum.
 12. Visible Light Transmittance: <Insert number> percent minimum.
 13. SGHC: <Insert value> maximum.
 14. Safety glazing required.
- I. Reflective-Coated Insulating Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Kind CV (coated vision glass) [, except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than **6 feet** above the adjacent floor level or cannot be approached closer than **10 feet**].
 3. Coating Type: [Pyrolytic] [Sputter-coating (vacuum deposition process)].
 4. Coating Color: [Gold] [Pewter] [Silver] <Insert color>.
 5. Overall Unit Thickness: [**1 inch**] [**5/8 inch**] <Insert dimension>.
 6. Minimum Thickness of Each Glass Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 7. Outdoor Lite: [Clear annealed] [Clear heat-strengthened] [Clear fully tempered] [Tinted heat-strengthened] [Tinted fully tempered] float glass.
 8. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.

9. Interspace Content: **[Air]** **[Argon]**.
 10. Indoor Lite: Clear **[annealed]** **[heat-strengthened]** **[fully tempered]** float glass.
 11. Coating Location: **[First]** **[Second]** **[Third]** surface.
 12. Outdoor Visible Reflectance: **<Insert number>** percent maximum.
 13. Winter Nighttime U-Factor: **<Insert value>** maximum.
 14. Summer Daytime U-Factor: **<Insert value>** maximum.
 15. Visible Light Transmittance: **<Insert number>** percent minimum.
 16. SGHC: **<Insert value>** maximum.
 17. Low-Maintenance Coating: Pyrolytic coating on first surface.
 18. Safety glazing required.
- J. **[Ceramic]** **[Silicone]**-Coated, Insulating Spandrel Glass Type **<Insert drawing designation>**:
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Coating Color: **[As selected by Architect from manufacturer's full range]** **[Match Architect's samples]** **<Insert one manufacturer's color designation if matching is required>** **<Insert manufacturer's name; color designation>**.
 3. Overall Unit Thickness: **[1 inch]** **<Insert dimension>**.
 4. Minimum Thickness of Each Glass Lite: **[5 mm]** **[6 mm]** **<Insert thickness>**.
 5. Outdoor Lite: **[Clear annealed]** **[Clear heat-strengthened]** **[Clear fully tempered]** **[Low-iron annealed]** **[Low-iron heat-strengthened]** **[Low-iron fully tempered]** float glass.
 6. Interspace Content: **[Air]** **[Argon]**.
 7. Indoor Lite: **[Clear annealed]** **[Clear heat-strengthened]** **[Clear fully tempered]** **[Low-iron annealed]** **[Low-iron heat-strengthened]** **[Low-iron fully tempered]** float glass.
 8. Coating Location: Fourth surface.
 9. Winter Nighttime U-Factor: **<Insert value>** maximum.
 10. Summer Daytime U-Factor: **<Insert value>** maximum.
- K. **[Ceramic]** **[Silicone]**-Coated, Low-E, Insulating Spandrel Glass Type **<Insert drawing designation>**:
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Coating Color: **[As selected by Architect from manufacturer's full range]** **[Match Architect's samples]** **<Insert one manufacturer's color designation if matching is required>** **<Insert manufacturer's name; color designation>**.

3. Overall Unit Thickness: [**1 inch**] <Insert dimension>.
4. Minimum Thickness of Each Glass Lite: [**5 mm**] [**6 mm**] <Insert thickness>.
5. Outdoor Lite: [Clear heat-strengthened] [Clear fully tempered] [Low-iron heat-strengthened] [Low-iron fully tempered] float glass.
6. Interspace Content: [**Air**] [**Argon**].
7. Indoor Lite: [Clear heat-strengthened] [Clear fully tempered] [Low-iron heat-strengthened] [Low-iron fully tempered] float glass.
8. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
9. Opaque Coating Location: Fourth surface.
10. Winter Nighttime U-Factor: <Insert value> maximum.
11. Summer Daytime U-Factor: <Insert value> maximum.

L. [**Ceramic**] [**Silicone**]-Coated, Tinted, Insulating Spandrel Glass Type <Insert drawing designation>:

1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
2. Coating Color: [As selected by Architect from manufacturer's full range] [Match Architect's samples] <Insert one manufacturer's color designation if matching is required> <Insert manufacturer's name; color designation>.
3. Overall Unit Thickness: [**1 inch**] <Insert dimension>.
4. Minimum Thickness of Each Glass Lite: [**5 mm**] [**6 mm**] <Insert thickness>.
5. Outdoor Lite: Tinted [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
6. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
7. Interspace Content: [**Air**] [**Argon**].
8. Indoor Lite: Clear [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
9. Coating Location: Fourth surface.
10. Winter Nighttime U-Factor: <Insert value> maximum.
11. Summer Daytime U-Factor: <Insert value> maximum.

3.11 INSULATING-LAMINATED-GLASS SCHEDULE

A. Clear Insulating, Laminated Glass Type <Insert drawing designation>:

1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
2. Overall Unit Thickness: [**1-3/16 inch**] [**1 inch**] [**3/4 inch**] <Insert dimension>.

3. Minimum Thickness of Outdoor Lite: [3 mm] [4 mm] [5 mm] [6 mm] <Insert thickness>.
 4. Outdoor Lite: Clear [heat-strengthened] [fully tempered] float glass.
 5. Interspace Content: [Air] [Argon].
 6. Indoor Lite: Clear laminated glass with two plies of [annealed] [heat-strengthened] [fully tempered] float glass.
 - a. Minimum Thickness of Each Glass Ply: [3 mm] [4 mm] [5 mm] [6 mm] [As indicated] <Insert thickness>.
 - b. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].
 7. Winter Nighttime U-Factor: <Insert value> maximum.
 8. Summer Daytime U-Factor: <Insert value> maximum.
 9. SGHC: <Insert value> maximum.
 10. Safety glazing required.
- B. Low-E-Coated, Clear Insulating Laminated Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [1-3/16 inch] [1 inch] [3/4 inch] <Insert dimension>.
 3. Minimum Thickness of Outdoor Lite: [3 mm] [4 mm] [5 mm] [6 mm] <Insert thickness>.
 4. Outdoor Lite: Clear [heat-strengthened] [fully tempered] float glass.
 5. Interspace Content: [Air] [Argon].
 6. Indoor Lite: Clear laminated glass with two plies of [annealed] [heat-strengthened] [fully tempered] float glass.
 - a. Minimum Thickness of Each Glass Ply: [3 mm] [4 mm] [5 mm] [6 mm] [As indicated] <Insert thickness>.
 - b. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].
 7. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 8. Winter Nighttime U-Factor: <Insert value> maximum.
 9. Summer Daytime U-Factor: <Insert value> maximum.
 10. Visible Light Transmittance: <Insert number> percent minimum.
 11. SGHC: <Insert value> maximum.
 12. Safety glazing required.

- C. Tinted, Insulating Laminated Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [**1-3/16 inch**] [**1 inch**] [**3/4 inch**] <Insert dimension>.
 3. Minimum Thickness of Outdoor Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: Tinted [**heat-strengthened**] [**fully tempered**] float glass.
 5. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 6. Interspace Content: [**Air**] [**Argon**].
 7. Indoor Lite: Clear laminated glass with two plies of [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 - a. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 - b. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 8. Winter Nighttime U-Factor: <Insert value> maximum.
 9. Summer Daytime U-Factor: <Insert value> maximum.
 10. Visible Light Transmittance: <Insert number> percent minimum.
 11. SGHC: <Insert value> maximum.
 12. Safety glazing required.
- D. Low-E-Coated, Tinted, Insulating Laminated Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [**1-3/16 inch**] [**1 inch**] [**3/4 inch**] <Insert dimension>.
 3. Minimum Thickness of Outdoor Lite: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] <Insert thickness>.
 4. Outdoor Lite: Tinted [**heat-strengthened**] [**fully tempered**] float glass.
 5. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 6. Interspace Content: [**Air**] [**Argon**].
 7. Indoor Lite: Clear laminated glass with two plies of [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 - a. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 - b. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].

8. Low-E Coating: [Pyrolytic on second] [Pyrolytic on third] [Sputtered on second] [Sputtered on third] [Pyrolytic or sputtered on second or third] surface.
 9. Winter Nighttime U-Factor: <Insert value> maximum.
 10. Summer Daytime U-Factor: <Insert value> maximum.
 11. Visible Light Transmittance: <Insert number> percent minimum.
 12. SGHC: <Insert value> maximum.
 13. Safety glazing required.
- E. Reflective-Coated, Insulating Laminated Glass Type <Insert drawing designation>:
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Kind CV (coated vision glass) [, except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than **6 feet** above the adjacent floor level or cannot be approached closer than **10 feet**].
 3. Coating Type: [Pyrolytic] [Sputter-coating (vacuum deposition process)].
 4. Coating Color: [Gold] [Pewter] [Silver] <Insert color>.
 5. Overall Unit Thickness: [**1-3/16 inch**] [**1 inch**] <Insert dimension>.
 6. Minimum Thickness of Outdoor Lite: [**6 mm**] <Insert thickness>.
 7. Outdoor Lite: [Clear heat-strengthened] [Clear fully tempered] [Tinted heat-strengthened] [Tinted fully tempered] float glass.
 8. Tint Color: [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 9. Interspace Content: [**Air**] [**Argon**].
 10. Indoor Lite: Clear laminated glass with two plies of [**annealed**] [**heat-strengthened**] [**fully tempered**] float glass.
 - a. Minimum Thickness of Each Glass Ply: [**3 mm**] [**4 mm**] [**5 mm**] [**6 mm**] [**As indicated**] <Insert thickness>.
 - b. Interlayer Thickness: [**0.030 inch**] [**0.060 inch**] [**0.090 inch**].
 11. Coating Location: [**First**] [**Second**] [**Third**] surface.
 12. Outdoor Visible Reflectance: <Insert number> percent maximum.
 13. Winter Nighttime U-Factor: <Insert value> maximum.
 14. Summer Daytime U-Factor: <Insert value> maximum.
 15. Visible Light Transmittance: <Insert number> percent minimum.
 16. SGHC: <Insert value> maximum.

17. Low-Maintenance Coating: Pyrolytic coating on first surface.
18. Safety glazing required.

END OF SECTION

SECTION 08 83 00

MIRRORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Silvered flat glass mirrors.
- B. Related Requirements:
 - 1. Section 08 80 00 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
 - 2. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- C. Samples: For each type of the following:
 - 1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
 - 2. Mirror Clips: Full size.
 - 3. Mirror Trim: 12 inches long.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of mirror [**and mirror mastic**].
- C. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.
- D. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For mirrors to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.
 - 1. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors in accordance with mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.08 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
 - 1. Warranty Period: [Five] <Insert number> years from date of [Substantial Completion] [manufacture].

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Manufacturers: Subject to compliance with requirements, provide mirrors by one of the following:
 - 1. Guardian Industries Corp.
 - 2. Arch Aluminum & Glass Co., Inc.
 - 3. Virginia Mirror Company, Inc.
 - 4. VVP America, Inc.; Binswanger Mirror Products.
 - 5. Walker Glass Co., Ltd.
 - 6. Or Equal.

2.02 SOURCE LIMITATIONS

- A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- B. Source Limitations for Mirror Accessories: Obtain mirror-glazing accessories from single source.

2.03 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C1503[; manufactured using copper-free, low-lead mirror coating process].
- B. Annealed Monolithic Glass Mirrors: Mirror [Select] [Glazing] Quality, [clear] [low-iron (low-iron) float glass with a minimum 91 percent visible light transmission] [tinted].
1. Nominal Thickness: [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness>.
 2. Tint Color: [Blue] [Black] [Bronze] [Gold] [Gray] [Green] [Peach] [Pink] <Insert color>.
- C. Tempered Glass Mirrors: Mirror Glazing Quality for blemish requirements and complying with ASTM C1048 for Kind FT, Condition A, tempered float glass before silver coating is applied; [clear] [tinted].
1. Nominal Thickness: [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness>.
 2. Tint Color: [Blue] [Black] [Bronze] [Gold] [Gray] [Green] [Peach] [Pink] <Insert color>.
- D. Laminated Mirrors: ASTM C1172, Type II.
1. Glass for Outer Lite: Annealed float glass, Mirror [Select] [Glazing] Quality, [clear] [low-iron (low-iron) float glass with a minimum 91 percent visible light transmission] [tinted].
 - a. Tint Color: [Blue] [Black] [Bronze] [Gold] [Gray] [Green] [Peach] [Pink] <Insert color>.
 2. Nominal Thickness for Outer Lite: [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness>.
 3. Glass for Inner Lite: [Annealed float glass; ASTM C1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear)] [Heat-strengthened float glass; ASTM C1048, Type I; Quality-Q3; Class I (clear) Kind HS, Condition A] [Tempered float glass; ASTM C1048, Type I; Quality-Q3; Class I (clear), Kind FT, Condition A].
 4. Nominal Thickness: [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] [As indicated] <Insert thickness>.
 5. Interlayer: Mirror manufacturer's standard 0.030-inch-thick, clear polyvinyl-butylal interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.
- E. Safety Glazing Products: For [film-backed] [laminated] [tempered] mirrors, provide products that comply with 16 CFR 1201, Category II.

2.04 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

- D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.05 MIRROR HARDWARE

- A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
 - 1. Aluminum J-Channel Bottom and Side Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
 - 2. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
 - 3. Finish: **[Clear]** **[Gold]** bright anodized.
- B. Aluminum J-Channels and Cleat: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
 - 1. Aluminum J-Channel and Cleat, Bottom and Side Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch in height, respectively.
 - 2. Aluminum J-Channel and Cleat, Top Trim: Formed with front leg with a height matching bottom trim and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
 - 3. Finish: **[Clear]** **[Gold]** bright anodized.
- C. Mirror Bottom Clips: **[As indicated]** <Insert description and finish or product designation and manufacturer's name>.
- D. Mirror Top Clips: **[As indicated]** <Insert description and finish or product designation and manufacturer's name>.
- E. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
 - 1. Profile: As indicated.
 - 2. Finish: <Insert manufacturer's finish designation and name>.
- F. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- G. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.06 FABRICATION

- A. Shop fabricate mirrors to greatest extent possible.
- B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: **[Flat polished]** **[Rounded polished]** **[Flat high polished]** **[Rounded high polished]** **[Beveled polished edge of width shown]**.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
- D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.02 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.03 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
 1. NGA Publications: **["Laminated Glazing Reference Manual,"]"Glazing Manual" and "Installation Techniques Designed to Prolong the Life of Flat Glass Mirrors."**
- B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Install mirrors with **[mastic and] mirror** hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
 2. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
 3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips **[where indicated] [so they are symmetrically placed and evenly spaced]**.
 4. Install mastic as follows:

- a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
- b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
- c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

3.04 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION

SECTION 08 87 33

ARCHITECTURAL WINDOW FILM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Removing existing window film and preparing surface for new solar shading and safety film.
2. Providing new solar shading and safety film applied to glass where indicated on the Drawings.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation meeting:

1. Arrange for a Preinstallation meeting between the Contractor, Architect and Installer, at least a week prior to the start of installation to review proposed methods and processes.
2. Review Project schedule, scope of work indicated to receive the film, coordination between glazier and film Installer, scheduled finish, acceptability of glass, submittals and approvals.
3. Review procedures to be followed for protection of film during and after installation.
4. Record minutes of the meeting, decisions made and corrective measures to be taken before application starts. Send copy of the minutes to those present and the Architect no later than 3 days following the meeting.

1.03 SUBMITTALS

- A. Shop Drawings: Where joints will occur in the film due to the size of the glass, submit Shop Drawings showing joint locations which are subject to rejection by the Architect.
- B. Samples: Submit three 24-inch square Samples of clear glass with the film applied to one half of the glass on both glass surfaces.
- C. Product Data: Manufacturer Product Data sheets on each product to be used, including.
 1. Physical properties and independent testing agency reports showing compliance with specified tests.
 2. Preparation instructions and recommendations.
 3. Storage and handling requirements and recommendations.
 4. Provide detailed description of the installation method.
- D. Closeout Submittals:
 1. Film manufacturer's instructions for maintenance and precautions to be used to clean film without damaging it.
 2. Minimum quantity of film: properly packaged and labeled, equal to one percent of the quantity installed.
 3. Name, address (physical and email), and telephone number of Installer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of 10 years' experience.
- B. Installer's Qualifications: Firm and individuals with a minimum of 5 consecutive years' experience in installation of window films for projects similar in material, design, complexity and extent to this Project, and whose work has resulted in applications with a record of successful in-service performance.
- C. Mockup: Provide a mockup for evaluation of surface preparation techniques and application workmanship.
 - 1. Apply film to one window designated by the Architect.
 - 2. Do not proceed with remaining work until workmanship and color, is approved by Architect.
- D. Fire Performance: Surface burning characteristics when tested in accordance ASTM E 84:
 - 1. Flame Spread: 25, maximum.
 - 2. Smoke Developed: 450, maximum.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products indoors, off the floor, in manufacturer's unopened packaging until ready for installation.

1.06 PROJECT CONDITIONS

- A. Maintain environmental conditions {temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. 3M Window Film (basis of design.)
- B. Hanita Coatings RCA LTD, distributed under the Sabra Window Films.
- C. Or equal.

2.02 SOLAR SHADING AND SAFETY FILM

- A. Design is based on 3M Prestige Series PR70.

PART 3 EXECUTION

3.01 EXAMINATION`

- A. Examination: Examine conditions affecting the work of this Section.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions,

3.03 INSTALLATION

- A. Install film in accordance with its manufacturer's instructions by recognized professional installers of film. Completed work must meet IWFA and these Specifications visual acceptance standard; in case of conflicts, the most stringent requirement shall take precedence.
- B. Install without bubbles, ripples, drips, dirt, cuts, tears or gaps between film and frame and between film panels when the length or width exceeds manufacturer's standard size; in all cases obtain the Architect's approval of joint locations.
- C. Clean newly installed film and window frames immediately after installation, using caution not to displace the film.
- D. Clean up cleaning solutions, run-off cleaning water and adhesive mounting solution.

3.04 PROTECTING

- A. Protect installed products until completion of Project.
- B. Where installed film could be damaged by subsequent construction provide tape warning strips or barricades to prevent contact. Do not apply tape directly to film.

END OF SECTION

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SECTION 08 91 19

FIXED LOUVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fixed [extruded-aluminum] [and] [formed-metal] louvers.
2. Fixed formed-metal acoustical louvers.
3. Blank-off panels for louvers

B. Related Requirements:

1. Section 08 11 13 "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.
2. Section 08 14 16 "Flush Wood Doors" for louvers in flush wood doors.
3. Section 09 91 13 "Exterior Painting" for field painting exterior louvers.
4. Section 09 91 23 "Interior Painting" for field painting interior louvers.

1.02 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.
- D. Delegated Design Submittal: For louvers indicated to comply with structural **[and seismic]** performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.07 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: **[Five] [10] [20] <Insert number>** years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: **[Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain fixed **[and operable]** louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural **[and seismic]** performance requirements and design criteria indicated.
- B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
 1. Wind Loads:
 - a. Determine loads based on pressures as indicated on Drawings.
 - b. Determine loads based on a uniform pressure of **[20 lbf/sq. ft.] [30 lbf/sq. ft.] <Insert value>**, acting inward or outward.
 - c. Determine loads based on pressures indicated below:

- 1) Corner Zone: Within **<Insert distance>** of building corners, uniform pressure of **<Insert design wind pressure>**, acting inward, and **<Insert design wind pressure>**, acting outward.
 - 2) Other Than Corner Zone: Uniform pressure of **<Insert design wind pressure>**, acting inward, and **<Insert design wind pressure>**, acting outward.
- C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade pass **[basic]** **[enhanced]** protection, when tested in accordance with AMCA 540.
- D. Seismic Performance:
1. As indicated on Drawings.
 2. Louvers, including attachments to other construction, withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** **<Insert requirement>**.
 - a. Design earthquake spectral response acceleration, short period (Sds) for Project is **<Insert value>**.
 - b. Component Importance Factor: **[1.5]** **[1.0]**.
- E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): **[120 deg F, ambient; 180 deg F, material surfaces]** **<Insert temperature range>**.
- G. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.03 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Nondrainable-Blade Louver, Extruded Aluminum **<Insert drawing designation>**:
1. Louver Depth: **[2 inches]** **[4 inches]** **[6 inches]** **<Insert dimension>**.
 2. Blade Profile: **[Plain blade without]** **[Blade with]** center baffle.
 3. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** **[0.060 inch]** for blades and **0.080 inch** for frames].
 4. Mullion Type: **[Exposed]** **[Semirecessed]** **[Fully recessed]**.
 5. Louver Performance Ratings:
 - a. Free Area: Not less than **[7.5 sq. ft.]** **[8.0 sq. ft.]** **[8.5 sq. ft.]** **<Insert value>** for 48-inch-wide by 48-inch-high louver.

- b. Point of Beginning Water Penetration: Not less than **[700 fpm] [750 fpm] [800 fpm] [850 fpm] [900 fpm] [950 fpm]** <Insert value>.
 - c. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[650-fpm] [700-fpm] [750-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- B. Horizontal Drainable-Blade Louver, Extruded Aluminum **<Insert drawing designation>**:
1. Louver Depth: **[4 inches] [6 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch] [0.060 inch for blades and 0.080 inch for frames]**.
 3. Mullion Type: Exposed.
 4. Louver Performance Ratings:
 - a. Free Area: Not less than **[7.0 sq. ft.] [7.5 sq. ft.] [8.0 sq. ft.] [8.5 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[900 fpm] [950 fpm] [1000 fpm] [1050 fpm] [1100 fpm]** <Insert value>.
 - c. Air Performance:
 - 1) Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[700-fpm] [750-fpm] [800-fpm] [850-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 - 2) Not more than **[0.15-inch wg]** <Insert value> static pressure drop at **[900-fpm] [950-fpm] [1000-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- C. Horizontal, Continuous-Line, Drainable-Blade Louver, Extruded Aluminum **<Insert drawing designation>**: Drainable-blade louver with blade gutters (drains) in rear two-thirds of blades only.
1. Louver Depth: **[6 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
 3. Mullion Type: Semirecessed.
 4. Louver Performance Ratings:
 - a. Free Area: Not less than **[7.8 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[850 fpm]** <Insert value>.

- c. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[800-fpm]** <Insert value> free-area **[exhaust]** **[intake]** velocity.
 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- D. Horizontal, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum <Insert drawing designation>:
 1. Louver Depth: **[4 inches]** **[5 inches]** **[7 inches]** **[8 inches]** **[9 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** **[0.060 inch]** for blades and **0.080 inch** for frames].
 3. Louver Performance Ratings:
 - a. Free Area: Not less than **[5.0 sq. ft.]** **[6.0 sq. ft.]** **[7.0 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[600-fpm]** **[700-fpm]** **[800-fpm]** <Insert value> free-area **[exhaust]** **[intake]** velocity.
 - c. Wind-Driven Rain Performance: Not less than **[99]** **[95]** **[80]** <Insert number> percent effectiveness when subjected to a rainfall rate of **[3 inches per hour and a wind speed of 29 mph]** **[8 inches per hour and a wind speed of 50 mph]** at a core-area intake velocity of **[300 fpm]** **[400 fpm]** **[500 fpm]** <Insert value>.
 4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- E. Vertical, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum <Insert drawing designation>:
 1. Louver Depth: **[4 inches]** **[6 inches]** **[8 inches]** **[9 inches]** **[12 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** **[0.060 inch]** for blades and **0.080 inch** for frames].
 3. Louver Performance Ratings:
 - a. Free Area: Not less than **[5.0 sq. ft.]** **[6.0 sq. ft.]** **[7.0 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[600-fpm]** **[700-fpm]** **[800-fpm]** <Insert value> free-area **[exhaust]** **[intake]** velocity.
 - c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of **[3 inches per hour and a wind speed of 29 mph]** **[8 inches per hour and a wind speed of 50 mph]** at a core-area intake velocity of **[300 fpm]** **[400 fpm]** **[500 fpm]** <Insert value>.
 4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

- F. Horizontal, Drainable-Blade, Windborne-Debris-Impact-Resistant Louver, Extruded Aluminum **<Insert drawing designation>**:
1. Louver Depth: **[4 inches] [6 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** <Insert dimension>.
 3. Mullion Type: Exposed.
 4. Louver Performance Ratings:
 - a. Free Area: Not less than **[8.5 sq. ft.] [9.0 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[1077 fpm] [1100 fpm]** <Insert value>.
 - c. Air Performance:
 - 1) Not more than **[0.16-inch wg]** <Insert value> static pressure drop at **[989-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 - 2) Not more than **[0.15-inch wg]** <Insert value> static pressure drop at **[1077-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
 6. AMCA Rating: AMCA 540.
- G. Vertical, Wind-Driven-Rain-Resistant, Windborne-Debris-Impact-Resistant Louver, Extruded Aluminum **<Insert drawing designation>**:
1. Louver Depth: **[5 inches] [6 inches]** <Insert dimension>.
 2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch] [0.060 inch]** for blades and **0.080 inch** for frames] **[0.060 inch]** for blades and **0.095 inch** for frames].
 3. Louver Performance Ratings:
 - a. Free Area: Not less than **[7.0 sq. ft.] [8.5 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Air Performance: Not more than **[0.18-inch wg]** <Insert value> static pressure drop at **[1250-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 - c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of **[3 inches per hour and a wind speed of 29 mph]** **[8 inches per hour and a wind speed of 50 mph]** at a core-area intake velocity of **[782 fpm] [875 fpm] [989 fpm]** <Insert value>.
 4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
 5. AMCA Rating: AMCA 540, AMCA 550.
- H. Horizontal, Sightproof, Drainable-Blade Louver, Extruded Aluminum **<Insert drawing designation>**:

1. Louver Depth: **[5 inches]** <Insert dimension>.
2. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** **[0.060 inch]** for blades and **0.080 inch** for frames].
3. Mullion Type: Exposed.
4. Louver Performance Ratings:
 - a. Free Area: Not less than **[8.3 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[750 fpm]** **[950 fpm]** <Insert value>.
 - c. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[550-fpm]** <Insert value> free-area **[exhaust]** **[intake]** velocity.
5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

I. Vertical Sightproof Louver, Extruded Aluminum <Insert drawing designation>:

1. Louver Depth: **[4 inches]** <Insert dimension>.
2. Blade Profile: **[Chevron]** **[Y]** **[Labyrinth]**-shaped blade.
3. Frame and Blade Nominal Thickness: Not less than **[0.080 inch]** **[0.060 inch]** for blades and **0.080 inch** for frames].
4. Blade Spacing: **[2 inches]** **[4 inches]** <Insert dimension> o.c.
5. Mullion Type: **[Exposed]** **[Semirecessed]** **[Fully recessed]**.

2.04 FIXED FORMED-METAL LOUVERS

A. Horizontal Nondrainable-Blade Louver, Formed Metal <Insert drawing designation>:

1. Louver Depth: **[4 inches]** **[6 inches]** <Insert dimension>.
2. Blade Profile: **[Plain blade without]** **[Blade with]** center baffle.
3. Frame and Blade Material and Nominal Thickness:
 - a. Galvanized-steel sheet, not less than **[0.052 inch]** for frames and **0.040 inch** for blades] **[0.052 inch]** **[0.064 inch]**.
 - b. Stainless steel sheet, not less than **[0.050 inch]** **[0.062 inch]**.
4. Mullion Type: **[Exposed]** **[Semirecessed]** **[Fully recessed]**.
5. Louver Performance Ratings:
 - a. Free Area: Not less than **[6.5 sq. ft.]** **[7.0 sq. ft.]** **[7.5 sq. ft.]** **[8.0 sq. ft.]** <Insert value> for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[550 fpm]** **[600 fpm]** **[650 fpm]** **[700 fpm]** <Insert value>.

- c. Air Performance: Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[550-fpm]** **[600-fpm]** **[650-fpm]** **[700-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- B. Horizontal Drainable-Blade Louver, Formed Metal **<Insert drawing designation>**:
 - 1. Louver Depth: **[4 inches]** **[6 inches]** <Insert dimension>.
 - 2. Frame and Blade Material and Nominal Thickness:
 - a. Galvanized-steel sheet, not less than **[0.052 inch]** for frames and **0.040 inch** for blades] **[0.052 inch]** **[0.064 inch]**.
 - b. Stainless steel sheet, not less than **[0.050 inch]** **[0.062 inch]**.
 - 3. Mullion Type: Exposed.
 - 4. Louver Performance Ratings:
 - a. Free Area: Not less than **[7.0 sq. ft.]** **[7.5 sq. ft.]** **[8.0 sq. ft.]** **[8.5 sq. ft.]** **<Insert value>** for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than **[800 fpm]** **[850 fpm]** **[900 fpm]** **[950 fpm]** **[1000 fpm]** <Insert value>.
 - c. Air Performance:
 - 1) Not more than **[0.10-inch wg]** <Insert value> static pressure drop at **[700-fpm]** **[750-fpm]** **[800-fpm]** **[850-fpm]** <Insert value> free-area [exhaust] [intake] velocity.
 - 2) Not more than **[0.15-inch wg]** <Insert value> static pressure drop at **[900-fpm]** **[950-fpm]** **[1000-fpm]** <Insert value> free-area velocity.
 - 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.05 FIXED ACOUSTICAL LOUVERS

- A. Acoustic Performance: Provide acoustical louvers complying with ratings specified, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width for **[airborne sound-transmission loss in accordance with ASTM E90]** **[outdoor-indoor, sound-transmission loss in accordance with ASTM E966]**.
- B. Fixed, Acoustical Louver, Formed Metal **<Insert drawing designation>**: Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish as blade.
 - 1. Louver Depth: **[6 inches]** **[8 inches]** **[12 inches]** <Insert dimension>.
 - 2. Frame Material:

- a. Extruded aluminum or aluminum sheet, not less than 0.080-inch nominal thickness.
- b. Galvanized-steel sheet, not less than **[0.052-inch]** **[0.064-inch]** nominal thickness.
3. Blade Material:
 - a. Aluminum sheet, not less than **[0.063-inch]** **[0.080-inch]** nominal thickness.
 - b. Galvanized-steel sheet, not less than **[0.034-inch]** **[0.040-inch]** **[0.052-inch]** nominal thickness.
4. Blade Shape: [Straight] [Airfoil] [Chevron].
5. Blade Angle: 45 degrees unless otherwise indicated.
6. Blade Spacing:
 - a. 6 inches o.c. for 6-inch-deep louvers.
 - b. **[6 inches]** **[8 inches]** o.c. for 8-inch-deep louvers.
 - c. **[9 inches]** **[12 inches]** o.c. for 12-inch-deep louvers.
7. Free Area: Not less than 4 sq. ft. for 48-inch-wide by 48-inch-high louver.
8. Airborne Sound-Transmission Loss: **[STC 10]** **<Insert STC value>** in accordance with ASTM E413, determined by testing in accordance with ASTM E90.
9. Outdoor-Indoor, Sound-Transmission Loss: **[OITC 10]** **<Insert OITC value>** in accordance with ASTM E1332, determined by testing in accordance with ASTM E966.

2.06 LOUVER SCREENS

- A. General: Provide screen at [each exterior louver] [louvers indicated].
 1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: **[Bird screening]** **[Bird screening, except where insect screening is indicated]** **[Insect screening]**.
- B. Secure screen frames to louver frames with **[stainless steel machine screws]** **[machine screws with heads finished to match louver]**, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 1. Metal: Same type and form of metal as indicated for louver to which screens are attached. **[Reinforce extruded-aluminum screen frames at corners with clips.]**
 2. Finish: **[Same finish as louver frames to which louver screens are attached]** **[Mill finish unless otherwise indicated]**.
 3. Type: **[Rewirable frames with a driven spline or insert]** **[Non-rewirable, U-shaped frames]**.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening, Aluminum: 1/2-inch-square mesh, 0.063-inch wire.
2. Bird Screening, Stainless Steel: 1/2-inch-square mesh, 0.047-inch wire.
3. Bird Screening, Flattened, Expanded Aluminum: 3/4 by 0.050 inch thick.
4. Insect Screening, Aluminum: 18-by-16 mesh, 0.012-inch wire.
5. Insect Screening, Stainless Steel: 18-by-18 mesh, 0.009-inch wire.

E. Louver Screening for Galvanized-Steel Louvers:

1. Bird Screening, Galvanized Steel: 1/2-inch-square mesh, 0.041-inch wire.
2. Bird Screening, Stainless Steel: 1/2-inch-square mesh, 0.047-inch wire.
3. Insect Screening, Galvanized Steel: 18-by-14 mesh, 0.011-inch wire.
4. Insect Screening, Stainless Steel: 18-by-18 mesh, 0.009-inch wire.

F. Louver Screening for Stainless Steel Louvers:

1. Bird Screening, Stainless Steel: 1/2-inch-square mesh, 0.047-inch wire.
2. Insect Screening, Stainless Steel: 18-by-18 mesh, 0.009-inch wire.

2.07 BLANK-OFF PANELS

A. Uninsulated Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than 0.050-inch nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than **[0.040-inch] [0.052-inch]** nominal thickness.
3. Stainless steel sheet for stainless steel louvers, not less than **[0.038-inch] [0.050-inch]** nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: **[Same finish applied to louvers] [Same finish type applied to louvers, but black color]**.
5. Attach blank-off panels with **[clips] [sheet metal screws] <Insert method>**.

B. Insulated Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: **[1 inch] [2 inches]**.
2. Metal Facing Sheets, Aluminum: Not less than 0.032-inch nominal thickness.
3. Metal Facing Sheets, Galvanized Steel: Not less than 0.028-inch nominal thickness.
4. Metal Facing Sheets, Stainless Steel: Not less than 0.031-inch nominal thickness.
5. Insulating Core: **[Rigid, glass-fiber-board insulation] [or] [extruded-polystyrene foam] <Insert insulation material>**.

6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard **[extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness] [channel frames]**, with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: [Same finish applied to louvers] [Same type of finish applied to louvers, but black color].
9. Attach blank-off panels with [clips] [sheet metal screws] <Insert method>.

2.08 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, **[G60] [G90]** zinc coating, mill phosphatized.
- D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, [No. 2B finish] [No. 2D finish] [No. 4 finish, with grain running parallel to length of blades and frame members] [No. 4 finish, with grain running perpendicular to length of blades and frame members] [No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members] [No. 6 finish].
- E. Fasteners: Use types and sizes to suit unit installation conditions.
 1. Use [Phillips flat-head] [hex-head or Phillips pan-head] [tamper-resistant] screws for exposed fasteners unless otherwise indicated.
 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
 3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
 4. For fastening stainless steel, use 300 series stainless steel fasteners.
 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.09 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern **[unless horizontal mullions are indicated] [where indicated]**.
 2. Horizontal Mullions: Provide horizontal mullions at joints **[unless continuous vertical assemblies are indicated] [where indicated]**.
- C. Maintain equal louver blade spacing [, including separation between blades and frames at head and sill,] to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
1. Frame Type: [Channel] [Exterior flange] [Interior flange] unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
 2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades, so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
 4. Exterior Corners: Prefabricated corner units with mitered [and welded blades] [blades with concealed close-fitting splices] and with [fully recessed] [semirecessed] mullions at corners.
- G. Provide [subsills made of same material as louvers] [or] [extended sills] for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds **[concealed from view] [, threaded fasteners, or both, as standard with louver manufacturer]** unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.
- 2.10 ALUMINUM FINISHES
- A. Finish louvers after assembly.

- B. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- C. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
1. Color: [Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- D. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical conversion coated with acid chromate-fluoride-phosphate.
- E. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than 2-mil dry film thickness.
- F. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- G. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- I. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- J. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- K. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- 2.11 GALVANIZED-STEEL SHEET FINISHES
- A. Finish louvers after assembly.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent, so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair in accordance with ASTM A780/A780M.
- C. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 2 mils.
1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- 2.12 STAINLESS STEEL SHEET FINISHES
- A. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 08 95 16

WALL VENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wall vents.
2. Flood and air vents.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of metal finish required.

1.03 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For flood vents, from ICC-ES.
- B. Sample Warranties: For manufacturer's special warranties.

1.04 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: **[Five] [10] [20]** <Insert number> years from date of Substantial Completion.

- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

- b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, peeling, or chipping.
2. Warranty Period: **[Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain vents from single source from single manufacturer.

2.02 WALL VENTS (BRICK VENTS)

- A. Extruded-Aluminum Wall Vents:

1. Extruded-aluminum louvers and frames, not less than 0.125-inch nominal thickness, assembled by welding; with 18-by-14-mesh, aluminum insect screening on inside face; incorporating weep holes, continuous drip at sill, and integral waterstop on inside edge of sill; of load-bearing design and construction.
2. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless steel components.
3. Finish: **[Mill]** <Insert finish>.

- B. Cast-Aluminum Wall Vents:

1. One-piece, cast-aluminum louvers and frames; with 18-by-14-mesh, aluminum insect screening on inside face; incorporating integral waterstop on inside edge of sill; of load-bearing design and construction.
2. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless steel components.
3. Finish: Mill.

2.03 FLOOD AND AIR VENTS

- A. Stainless Steel Flood and Air Vents: Type 316 stainless steel welded frame and flood door assembly, designed to automatically release under hydrostatic pressure or rising water level.

1. Ventilation Area: **[0.354 sq. ft.] [0.708 sq. ft.] [1.417 sq. ft.]** <Insert area>.
2. Flood Coverage: **[200 sq. ft.] [400 sq. ft.] [800 sq. ft.]** <Insert area>.
3. Finish: **[Mill]** <Insert finish>.

2.04 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Aluminum Castings: ASTM B26/B26M, Alloy 319.
- D. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, **[Type 304] [Type 316] [Type 304 or 316 as indicated]** <Insert type>.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.05 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- B. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
 - 1. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities]** <Insert color>.
- C. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical conversion coated with acid chromate-fluoride-phosphate.
- D. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than 2-mil dry film thickness.
- E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and gloss>.
- F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent PVDF resin by weight in color coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - 2. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and gloss>.
- G. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.

2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- I. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- J. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- 2.06 STAINLESS STEEL FINISHES
- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1. Run grain of directional finishes with long dimension of each piece.
 2. When polishing is completed, passivate and rinse surfaces.
 3. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Sheet and Plate Finishes:
1. Cold-Rolled, Bright Finish: ASTM A480/A480M, No. 2B.
 2. Directional Satin Finish: ASTM A480/A480M, No. 4.

- D. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install according to manufacturer's written instructions.
- B. Locate and place vents level, plumb, and at indicated alignment with adjacent work.
- C. Attach vents securely in place using fasteners supplied or approved by manufacturer.
- D. Protect unpainted surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- E. Build vents into masonry work as construction progresses; comply with requirements in Section 04 20 00 "Unit Masonry."
- F. Provide perimeter reveals of uniform width for sealants and joint fillers, where indicated.
- G. Use concealed anchorages.

3.02 ADJUSTING AND CLEANING

- A. Adjust flood vents for proper operation.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore vents damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION

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DIVISION 09

FINISHES

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SECTION 09 05 16

WATER VAPOR EMISSION CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes system for the reduction of moisture vapor transmission and alkalinity control for interior concrete slabs.

1.02 SUBMITTALS

- A. Submit the following product data:
 - 1. Product Data: Manufacturer's descriptive data and product attributes.
 - 2. Installation Instructions.
 - 3. Independent Test Data.
 - 4. Certification Requirements.
 - 5. Warranty Information.
- B. Manufacturer's certification that moisture vapor control products meet requirements of current version of ASTM F3010
- C. Independent test reports supporting product manufacturer's certificate of conformance to ASTM F3010
- D. Tests: Submit concrete floor moisture test results required by floor covering manufacturer. Perform moisture testing as described in ASTM Practice F710. Testing shall be performed according to the floor covering manufacturer's specified ASTM Standard Test Method by an independent Testing Agency. Testing shall be performed by ICRI Tier 2 Certified Moisture Testing Technician. Provide moisture test results to the Architect, Owner, General Contractor, and Moisture Vapor Control System Manufacturer's Representative.

1.03 QUALITY ASSURANCE

- A. Manufacturer qualifications: Firm with not less than 10 years experience in manufacturing water vapor reduction systems.
 - 1. The water vapor reduction system must be specifically formulated and marketed for water vapor reduction and alkalinity control without change of system design for a minimum period of five (5) years.
 - 2. Submit list of product use and performance history, for the same formulation and system design, listing reference sources for at least 3 projects dating back for a minimum of 5 years.
- B. Applicator qualifications: Entity currently approved or certified by the manufacturer, experienced in surface preparation and application of the material and subject to inspection of the manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the job site in their original unopened containers, clearly labeled with the manufacturer's name and brand designation.
- B. Store products in an approved ventilated dry area; protect from dampness, freezing, and direct sun light. Product should not be stored in areas with temperatures in excess of 90 degrees F or below 50 degrees F.
- C. Handle product in a manner that will prevent breakage of containers and damage products.

1.05 PROJECT/SITE CONDITIONS

- A. Environmental conditions
 - 1. Do not apply moisture vapor reduction system to unprotected surfaces or when water is accumulated on the surface of the concrete.
 - 2. Do not apply water vapor reduction system when temperature is lower than 50 degrees F or expected to fall below this temperature within 24 hours from time of application.
- B. Protection: Protect water vapor reduction system to prevent damage from active rain or topical water for a minimum period of 24 hours from time of application.

1.06 SCHEDULING

- A. Before installation of LVF, VCT, carpet and/or epoxy flooring systems over the interior concrete slabs, anhydrous calcium chloride testing ASTM F 1869 (latest revision) and RH Probe Tests ASTM F 2170 shall be performed by the Special Inspector as outlined In Article 3.1 below.
- B. Submit and install the water vapor reduction system, where required, before installation of floor finish.
- C. Allow for as much time as is reasonable for the concrete slab to dry before installing anhydrous calcium chloride tests and/or RH Probe Tests. All mastics, glues, and/or contaminants shall be removed to provide a clean, sound, concrete substrate prior to installing anhydrous calcium chloride tests as per ASTM F 1869 (latest revision).
- D. The water vapor reduction system must allow installation as early as 7 days after concrete placement.

1.07 WARRANTY

- A. Provide manufacturer's warranty against defects in materials and workmanship for 15 years from Substantial Completion.
- B. Correct failures during the warranty period at no cost to Owner.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Minimum 97 percent water vapor transmission reduction compared to untreated concrete, ASTM E 96, Water Vapor Transmission (wet methods).

- B. Not exceeding one perm rating, ASTM E 96 Perm Rating.
- C. Insensitivity to alkaline environment up to, and including, pH 14 in a 14-day bath test, ASTM D 1308.
- D. Certified acceptance and exposure to continuous topical water exposure after final cure.
- E. Water Vapor reduction system shall be a single coat, stand alone system with no requirements for additional components such as sand broadcast for adhesion of flooring systems.
- F. Reduce Calcium Chloride readings of up to 25lbs/1000 ft²/24 hrs by 97 percent in one coat.
- G. Perform as required with RH Probe readings of 100 percent.

2.02 MANUFACTURERS

- A. Water vapor reduction system, which may be incorporated in the work, shall be the product of a single manufacturer.
 - 1. VAP I® 2000 System by KOSTER American Corporation, basis of design.
 - 2. VaporSeal 390 by Floor Seal.
 - 3. Or equal.

2.03 MATERIALS

- A. General: Use materials of one manufacturer throughout the project.
 - 1. Moisture Vapor Control Coating: Select from among the following products
 - 2. KOSTER VAP I® 2000 12 hour setting time, low VOC, 2-part epoxy resin coating.
 - 3. KOSTER VAP I® 2000 FS 4 - 5 hour setting time, Zero VOC. 2-part epoxy resin coating
 - 4. KOSTER VAP I® 2000 UFS 3 - 4 hour setting time, low VOC, 2-part epoxy resin coating
 - 5. KOSTER VAP I® 2000 ZERO VOC 12 hour setting time, Zero VOC, 2-part epoxy resin coating
- B. Primer for underlayment: KOSTER VAP I® 06 Primer - non-porous substrate primer for use on VAP I® 2000 resin coating.
- C. Self-Leveling underlayment: Select from among the following products:
 - 1. KOSTER SL
 - 2. KOSTER SL Premium
 - 3. KOSTER SC
- D. Primer for porous concrete containing excessive near-surface voids or high concrete surface profile: KOSTER KB-Pox IN, low viscosity, high modulus, 2-part epoxy resin.
- E. Repair resin for non-movement joints and cracks: KOSTER KB-Pox IN low-viscosity, high modulus 2-part epoxy gravity-feed, crack injection resin.
- F. Thickening agent for repairing spalls and excessively rough concrete: KOSTER TA fiber thickening agent, non-silica.

- G. Movement joint sealant:
 - 1. KOSTER FS-H polysulfide resin joint sealant.
 - 2. Backer rod and accessory materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Provide information required in moisture control system manufacturer's pre-job checklist. Submit completed checklist to moisture control system manufacturer for review before installation of the moisture control system.
- B. Inspect all surfaces with regard to their suitability to receive moisture vapor reduction system with manufacturer's representative.
- C. Calcium Chloride and/or RH Probe test requirements:
 - 1. Conduct anhydrous calcium chloride tests according ASTM F 1869 protocols.
 - 2. Provide RH Probe Tests according to ASTM F 2170 protocols.
 - 3. Only conduct calcium chloride tests at the same temperature and humidity expected during normal use. If this is not possible, then the test conditions should be 75 degrees F +/-10 degrees F and 50+/-10 percent relative humidity. Maintain these conditions 48 hours prior to and during testing. Water vapor transmission levels are directly affected by ambient room temperature and readings conducted without a sustained ambient temperature are not acceptable.
 - 4. Submit test results with a marked up floor finish plan showing test results along with a written clarification on status of the ambient air temperature and humidity before start of testing.
- D. Concrete Slab Inspection:
 - 1. Test existing slabs (primarily), for concrete deficiencies and contaminates such as un-reacted water-soluble silicates, chlorides, A.S.R. (alkali-silica reaction), to avoid bonding issues. This testing shall be performed by Owner's independent testing agency using standard coring methods and review of the history of the slab installation if available. Concrete shall conform to ACI Committee 201 Report "Guide to Durable Concrete."
- E. Floor treatment calcium chloride tests: After proper cure (>72 hrs min.) of the moisture vapor reduction system, conduct calcium chloride tests to determine if the level of water vapor transmission and alkalinity are reduced to the Owner's specified levels in conjunction with the flooring manufacturer's installation requirements.
- F. Adhesion tests: Verify proper adhesion of flooring adhesives, coatings, and leveling compounds to the final vapor reduction coating system for acceptability.

3.02 PREPARATION

- A. Clean all surfaces to receive moisture vapor reduction system. Shot blast all floors to a Concrete Surface Profile (CSP) #3 or #4 and clean surfaces with an industrial vacuum cleaner and remove all residues from the substrate. Grinding is allowed only in areas not accessible by shot blasting. Remove defective materials, and foreign matter such as dust, adhesives, leveling compounds, paint, dirt, floor hardeners, bond breakers, oil, grease, curing agents, form release agents, efflorescence, laitance, Shot blast bee bees. Repair cracks, expansion joints, control joints, and open surface honeycombs and fill in accordance with vapor reduction manufacturer's recommendations. If concrete additives such as chlorides or any other soluble compounds that may contaminate surfaces have been used in the concrete mix do not use this product on that floor without written approval from the vapor reduction system manufacturer. Reinforcing fibers that are visible after shot blasting must be removed and vacuumed leaving no fibers left on the concrete surfaces. Provide an uncontaminated, sound surface. Do not acid-etch.
- B. Repair concrete prior to vapor reduction system installation by using system manufacturer-recommended bonding agent with approved concrete repair materials. Comply with all requirements as listed in vapor reduction manufacturer's technical data information.
- C. Ensure surfaces to be treated with moisture vapor reduction system have not previously been treated with other materials such as underlayments, screeds, penetrating sealants, or silicates. If this is the case, consult with the manufacturer prior to any application of moisture vapor reduction system.
- D. Testing for concrete deficiencies or contamination such as alkali silica reaction, untreated silicates, or organic residue is recommended.
- E. Shot blast a small test area and inspect surface profile with the finished flooring applicator. As the specified vapor reduction system is not a leveling material, make sure the flooring installer is aware that a feather finish or leveling material may be required to "flatten" or level the vapor reduction-treated concrete prior to flooring installation.

3.03 APPLICATION

- A. Coverage rates depend on the surface profile and porosity of the concrete substrate as well as the measured level of moisture. On average, a coverage rate of 75-150 ft²/gal.
- B. Apply one coat, using a squeegee and or 3/8 inch nap roller leaving no areas untreated. Allow to cure a minimum of 12 hours before installing flooring system.

3.04 PROTECTION

- A. Protect each coat during specified cure period from traffic, topical water and contaminants.

END OF SECTION

SECTION 09 21 16

GYPSUM BOARD SHAFT WALL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes vertical gypsum board shaftwall assemblies consisting of gypsum shaftwall boards, U-shaped metal floor and ceiling tracks, specially shaped studs, and gypsum boards on finished side or sides.
- B. Related requirements:
 - 1. Section 01 81 13 for Sustainable Design Requirements.
 - 2. Division 09 for other gypsum board systems.

1.02 SUBMITTALS

- A. Data: Manufacturer Product Data and installation instructions for shaftwall assemblies, including provisions for fixture and equipment anchorage.
- B. Shop Drawings: Large scale (minimum 1:4), dimensioned Shop Drawings showing provisions for fixture and equipment anchorage to systems.

1.03 QUALITY ASSURANCE

- A. Fire resistance: Where a fire resistance classification is indicated, provide materials, accessories, and application procedures listed by UL or tested according to ASTM E 119 for the type of construction shown, and approved by AHJ.
- B. Single source responsibility: Obtain shaftwall products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of shaftwall systems.

1.04 HANDLING AND JOB CONDITIONS

- A. As specified in Section 09 29 00 Gypsum Board. Store materials under cover, off the ground or floor, in a dry, ventilated space.

PART 2 PRODUCTS

2.01 GYPSUM BOARD MANUFACTURERS

- A. As specified in Section 09 29 00.

2.02 PERFORMANCE REQUIREMENTS

- A. Structural performance characteristics: Provide shaftwall assemblies designed and tested by its manufacturer, or a nationally recognized testing laboratory, to withstand the lateral loads specified, within the specified deflection limit.
 - 1. Lateral loading: 5 psf, except where otherwise indicated.

2. Deflection limit: L/240 of partition height except where more restrictive limits are specified or noted on the Drawings to avoid fracture or other damage, and/or delamination of finish material applied to gypsum board.
3. Modify and supplement manufacturer's standard systems to comply with performance requirements.

2.03 MATERIALS

- A. Metal framing: One of the following systems of the size indicated and gage required to comply with performance requirements specified.
 1. Clark Dietrick.
 2. Gold Bond I-Stud/J-Track.
 3. SCAFCO Corp. Shaftwall Studs.
 4. CEMCO/USG J-runners, E and C-H studs.
- B. Deflection compensation: Where studs extend to the underside of floor or roof slabs, secure at top with "Fire Trak Cavity Shadowline" track by Fire Trak Corp. or other Code-compliant assemblies acceptable to the Architect.
- C. Gypsum shaftliner board:
 1. ASTM C 1396, Type X, with moisture-resistant paper facings, maximum lengths available to eliminate or minimize end-to-end butt joints, thickness indicated by one of the manufacturers specified in Section 09 29 00.
 2. Georgia-Pacific DensGlass Shaft liner boards, or equal: Moisture-resistant, one-inch thick gypsum core with coated glass mat facings, meeting ASTM E 136 for non-combustibility, and passing ASTM D 3273 test for mold resistance.
- D. Gypsum board, accessories, including joint tape, compound, and laminating adhesive: As specified in Section 09 29 00.
- E. Acoustical insulation and sealant: As specified in Section 09 80 00.

PART 3 EXECUTION

3.01 EXAMINATION/PREPARATION

- A. Where offset anchor plates are required, install continuous units formed from hot-dip galvanized steel sheet of thickness indicated.
 1. Attach plates to building structure with fasteners spaced not more than 24 inches o.c. Secure ceiling runners (tracks) to offset plates with screws spaced not more than 24 inches o.c.
- B. Before enclosing cavity walls, thoroughly clean space and floor tracks of debris.
- C. Verify conditions and measurements affecting the work of this Section at site.
- D. Correct detrimental conditions before proceeding with installation.

3.02 INSTALLATION

- A. Comply with shaftwall components manufacturer's installation instructions, with applicable provisions of ASTM C 754 and C 840, and the following.
- B. Anchor and attach materials to comply with indicated fire-rating and performance requirements, and to comply with governing regulations.
- C. Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishing and similar work which cannot be adequately supported directly on shaftwall systems.
- D. Isolate shaftwall systems from transfer of structural loading, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
- E. Seal perimeter of each portion of work where it abuts other work.
 - 1. Install a bead of sealant to prevent dislocation by air pressure differential as specified in Section 09 80 00.
 - 2. Seal joints and penetrations in compliance with manufacturer's instructions.
- F. Trim:
 - 1. Where room side of system will be finished, install trim accessories in compliance with shaftwall manufacturer's instructions.
 - 2. Apply trim where edge of gypsum board would otherwise be exposed or semi-exposed, including terminations, openings, external corners, expansion and control joints and similar edges.
- G. Finish exposed gypsum board surfaces as specified in Section 09 29 00.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Framing systems.
2. Suspension systems.
3. Grid suspension systems.

B. Related Requirements:

1. Section 05 40 00 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.02 ACTION SUBMITTALS

A. Product Data:

1. Framing systems.
2. Suspension systems.
3. Grid suspension systems.

1.03 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For **[high-strength steel studs and tracks] [firestop tracks] [post-installed anchors] [and] [power-actuated fasteners]**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.04 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of **[the Certified Steel Stud Association] [the Steel Framing Industry Association] [the Steel Stud Manufacturers Association] [or] [the Supreme Steel Framing System Association]**.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For **[composite]** **[non-composite]** wall assemblies, limited to **[1/240]** **[1/360]** of the wall height based on horizontal loading of **[5 lbf/sq. ft.]** **[10 lbf/sq. ft.]** **<Insert value>**.
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. minimum as required by the IBC.
- F. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of **<Insert inches>**.

2.02 FRAMING SYSTEMS

- A. Framing Members, General: Comply with **[ASTM C645]** **[AISI S220 and ASTM C645, Section 10]** **[AISI S220]** for conditions indicated.
 - 1. Steel Sheet Components: Comply with **[ASTM C645]** **[AISI S220 and ASTM C645, Section 10]** **[AISI S220]** requirements for metal unless otherwise indicated
 - 2. Protective Coating: Comply with **[ASTM C645]** **[AISI S220]**; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.
 - a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.

- B. Studs and Track: [ASTM C645] [AISI S220 and ASTM C645, Section 10] [AISI S220].
1. Minimum Base-Steel Thickness: [As indicated on Drawings] [As required by performance requirements for horizontal deflection] **[0.0147 inch] [0.0179 inch] [0.0296 inch] [0.0329 inch]**.
 2. Depth: [As indicated on Drawings] **[3-5/8 inches] [6 inches] [4 inches] [2-1/2 inches] [1-5/8 inches]**.
- C. High-Strength Steel Studs and Tracks: Roll-formed with surface deformations to stiffen the framing members.
1. Minimum Base-Steel Thickness: [As indicated on Drawings] [As required by horizontal deflection performance requirements] **[0.0147 inch] [0.0180 inch]** <Insert thickness>.
 2. Depth: [As indicated on Drawings] **[3-5/8 inches] [6 inches] [4 inches] [2-1/2 inches] [1-5/8 inches]**.
- D. Slip-Type Head Joints: Where indicated, provide **[one of]** the following:
1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing **[1-1/2-inch] [2-inch] [2-1/2-inch] [3-inch]** <Insert dimension> minimum vertical movement.
 2. Single Long-Leg Track System: Top track with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 3. Double-Track System: Top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Steel Thickness: [As indicated on Drawings] **[0.0179 inch] [0.0269 inch] [0.0296 inch] [0.0329 inch]** <Insert thickness>.
- G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.
1. Depth: [As indicated on Drawings] **[1-1/2 inches]** <Insert depth>.

2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels:

1. Minimum Base-Steel Thickness: [As indicated on Drawings] **[0.0179 inch]** **[0.0296 inch]** **[0.0329 inch]** <Insert thickness>.
2. Depth: [As indicated on Drawings] **[7/8 inch]** **[1-1/2 inches]**.

I. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.

1. Configuration: [Asymmetrical] [or] [hat shaped].

J. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: [As indicated on Drawings] **[3/4 inch]** <Insert depth>.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 3/4 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.03 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES **[AC01]** **[AC193]** **[AC58]** [or] **[AC308]** as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: [Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor].
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.

- d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated:
Alloy **[Group 1]** **[Group 2]** stainless steel bolts, ASTM F593, and nuts,
ASTM F594.
- 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to
authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, [in size indicated on Drawings] **[1 by 3/16 inch]** by length
indicated] <Insert size>.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel
thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
 - 1. Depth: [As indicated on Drawings] **[2-1/2 inches]** **[2 inches]** **[1-1/2 inches]**.
- F. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-
wide flanges, 3/4 inch deep.
 - 2. Steel Studs and Tracks:
 - a. Minimum Base-Steel Thickness: [As indicated on Drawings] **[0.0179 inch]**
[0.0269 inch] **[0.0296 inch]** **[0.0329 inch]**.
 - b. Depth: [As indicated on Drawings] **[1-5/8 inches]** **[2-1/2 inches]** **[3-5/8 inches]**.
 - 3. High-Strength Steel Studs and Tracks:
 - a. Minimum Base-Steel Thickness: [As indicated on Drawings] **[0.0147 inch]**
[0.0180 inch] <Insert thickness>.
 - b. Depth: [As indicated on Drawings] **[1-5/8 inches]** **[2-1/2 inches]** **[3-5/8 inches]**.
 - 4. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.
 - a. Minimum Base-Steel Thickness: [As indicated on Drawings] **[0.0179 inch]**
[0.0296 inch] **[0.0329 inch]** <Insert thickness>.
 - 5. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound
transmission.
 - a. Configuration: [Asymmetrical] [or] [hat shaped].

2.04 GRID SUSPENSION SYSTEMS

- A. Grid Suspension Systems for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

2.05 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide **[one of]** the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLATION OF FRAMING SYSTEMS

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: [As required by horizontal deflection performance requirements] **[16 inches o.c.] [24 inches o.c.]** unless otherwise indicated.
2. Multilayer Application: [As required by horizontal deflection performance requirements] **[16 inches o.c.] [24 inches o.c.]** unless otherwise indicated.
3. Tile Backing Panels: [As required by horizontal deflection performance requirements] **[16 inches o.c.]** unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced **[24 inches]** <Insert dimension> o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.05 INSTALLATION OF SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: **[48 inches]** <Insert dimension> o.c.
2. Carrying Channels (Main Runners): **[48 inches]** <Insert dimension> o.c.
3. Furring Channels (Furring Members): **[16 inches]** **[24 inches]** <Insert dimension> o.c.

- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

- C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within **[performance limits established by referenced installation standards]** <Insert deflection limit>.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems [with hangers used for support] <Insert requirements>.
- 3.06 INSTALLATION OF GRID SUSPENSION SYSTEMS
- A. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- 3.07 FIELD QUALITY CONTROL
- A. Installation Tolerances: Install suspension systems that are level to within **[1/8 inch in 12 feet]** <Insert dimensions> measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 09 24 00
CEMENT PLASTERING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Metal lath.
 2. Accessories.
 3. Base-coat cement plaster.
 4. Cement plaster finish coats.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.03 ACTION SUBMITTALS

- A. Product Data:
1. For each type of product.
- B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.
- C. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and finish texture specified.
- D. Samples for Verification: For each type of factory-prepared finish coat and for each color and finish texture specified, 12 by 12 inches, and prepared on rigid backing.

1.04 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockups for each substrate and color and finish texture indicated for cement plastering, including accessories.
 - a. Size: **[100 sq. ft.] <Insert dimension>** in surface area.
 2. For interior plasterwork, simulate finished lighting conditions for review of mockups.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.06 FIELD CONDITIONS

- A. Comply with ASTM C926 requirements.
- B. Exterior Plasterwork:
 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 2. Apply plaster when ambient temperature is greater than 40 deg F.
 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F for at least 48 hours before plaster application, and continuously during and after application.
 1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
 2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.
- D. Factory-Prepared Finish Coats: Comply with manufacturer's written instructions for environmental conditions for applying finish coats.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated on Drawings, provide cement plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

2.02 METAL LATH

- A. Expanded Metal Lath: ASTM C847; cold-rolled carbon steel sheet, hot-dip galvanized with ASTM A653/A653M **[G60]** **[G90]** zinc coating.
 1. Flat Diamond-Mesh Lath: **[2.5 lb/sq. yd.] [3.4 lb/sq. yd.]**.

- a. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with **[10-minute] [60-minute]** water resistance.
 - 1) Provide water-resistive barrier **[at exterior locations]** **[where indicated on Drawings]** <Insert requirements>.
 2. Self-Furring Diamond-Mesh Lath: **[V-grooved] [Dimpled]**.
 - a. Weight: **[2.5 lb/sq. yd.] [3.4 lb/sq. yd.]**.
 - b. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with **[10-minute] [60-minute]** water resistance.
 - 1) Provide water-resistive barrier **[at exterior locations]** **[where indicated on Drawings]** <Insert requirements>.
 - c. Kraft-Paper Backing: Factory bonded to back of lath.
 - 1) Provide kraft-paper backing **[at interior locations]** **[where indicated on Drawings]** <Insert requirements>.
 3. 3/8-Inch (10-mm) Rib Lath: **[3.4 lb/sq. yd.] [4 lb/sq. yd.]**.
 - a. Kraft-Paper Backing: Factory bonded to back of lath.
- B. Wire-Fabric Lath:
1. Welded-Wire Lath: ASTM C933; self-furring, **[1.14 lb/sq. yd.] [1.95 lb/sq. yd.]**.
 2. Woven-Wire Lath: ASTM C1032; self-furring, with stiffener wires, 1.4 lb/sq. yd., with 1.5-inch openings, and woven from 0.051-inch diameter wire.
 3. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and **[in double layer, each having 10-minute] [with 10-minute] [with 60-minute]** water resistance.
 - a. Provide water-resistive barrier **[at exterior locations]** **[where indicated on Drawings]** <Insert requirements>.
- 2.03 ACCESSORIES
- A. General: Comply with requirements in ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
1. Foundation Weep Screed: Fabricated from hot-dip-galvanized steel sheet with ASTM A653/A653M **[G60] [G90]** zinc coating.
 2. Cornerite: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M **[G60] [G90]** zinc coating.

3. External- (Outside-) Corner Reinforcement: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M **[G60] [G90]** zinc coating.
 4. Cornerbeads: Fabricated from **[zinc] [zinc-coated (galvanized) steel] [or] [anodized aluminum]**.
 - a. Smallnose cornerbead with expanded flanges; use **[unless otherwise indicated] [at locations indicated on Drawings]** <Insert requirements>.
 - b. Smallnose cornerbead with perforated flanges; use **[on curved corners] [at locations indicated on Drawings]** <Insert requirements>.
 - c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use **[on columns and for finishing unit masonry corners] [at locations indicated on Drawings]** <Insert requirements>.
 - d. Bullnose cornerbead, radius 3/4-inch minimum, with expanded flanges; use **[unless otherwise indicated] [at locations indicated on Drawings]** <Insert requirements>.
 5. Casing Beads: Fabricated from **[zinc] [zinc-coated (galvanized) steel] [or] [anodized aluminum]**; square-edged style; with expanded flanges.
 6. Control Joints: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
 7. One-Piece Expansion Joints: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
 8. Two-Piece Expansion Joints: Fabricated from **[zinc] [zinc-coated (galvanized) steel] [or] [anodized aluminum]**; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.
- C. Plastic Accessories: Manufactured from high-impact PVC.
1. Cornerbeads: With perforated flanges.
 - a. Smallnose cornerbead; use **[unless otherwise indicated] [at locations indicated on Drawings]** <Insert requirements>.
 - b. Bullnose cornerbead, radius 3/4-inch minimum; use **[unless otherwise indicated] [at locations indicated on Drawings]** <Insert requirements>.
 2. Casing Beads: Square-edge style, with perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
 3. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.

4. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged **[1/2-inch-] [1-inch-] [1-1/2-inch-] <Insert dimension>** wide reveal; with perforated concealed flanges.

2.04 BASE-COAT CEMENT PLASTER

- A. General: Comply with requirements in ASTM C926 for applications indicated.
 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.
 2. Aggregate:
 - a. Sand: Use **[unless otherwise indicated] <Insert requirements>**.
 - b. Perlite: Use **[where required by fire-resistance-rated design designations from listing organization and publication indicated on Drawings] <Insert requirements>**.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
 2. Masonry Cement Mixes:
 - a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
 - b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
 3. Portland and Masonry Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
 4. Plastic Cement Mixes:
 - a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
 - b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

5. Portland and Plastic Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

C. Base-Coat Mix for Use over Solid Plaster Bases: Single base (scratch) coat for two-coat plasterwork as follows:

1. Low-Absorption Unit Masonry and Concrete Substrates:
 - a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.
2. High-Absorption Unit Masonry and Concrete Substrates:
 - a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
 - c. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - d. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2.05 CEMENT PLASTER FINISH COATS

A. Job-Mixed Finish-Coat Mix: Comply with requirements in ASTM C926.

1. Aggregates:
 - a. Sand: Use over base coats containing sand.
 - b. Perlite: Use over base coats containing perlite.
 - c. Exposed Aggregates: Use [where indicated on Drawings] <Insert requirements>.
2. Portland Cement Mix: For cementitious material, mix 1 part portland cement and **[3/4 to 1-1/2] [1-1/2 to 2]** parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
3. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.

4. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
 5. Plastic Cement Mix: Use 1 part plastic cement and 1-1/2 to 3 parts aggregate.
- B. Ready-Mixed Finish-Coat Plaster: Factory-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
1. Color: **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 2. Source Limitations: Obtain ready-mixed finish-coat plaster from single source from single manufacturer.
- C. Acrylic-Based Finish Coatings: Factory-mixed, acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
1. Color: **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 2. Texture: **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert texture>.
 3. Source Limitations: Obtain acrylic-based finish coating from single source from single manufacturer.

2.06 PLASTER MATERIALS

- A. Portland Cement: ASTM C150/C150M, **[Type I]** **[Type II]**.
1. Color for Finish Coats: **[White]** **[Gray]**.
- B. Masonry Cement: ASTM C91/C91M, Type N.
1. Color for Finish Coats: **[White]** **[Gray]**.
- C. Plastic Cement: ASTM C1328/C1328M.
- D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color **[to match Architect's sample]** <Insert requirements>.
- E. Lime: ASTM C206, Type S; or ASTM C207, Type S.
- F. Sand Aggregate: ASTM C897.
1. Color for Job-Mixed Finish Coats: **[White]** **[In color matching Architect's sample]**.
- G. Perlite Aggregate: ASTM C35.
- H. Exposed Aggregates for Finish Coats: **[For marblecrete finish, clean, sound, crushed marble matching color and size gradation of Architect's sample]** <Insert requirements>.

2.07 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in cement plaster.
- C. Bonding Compound: ASTM C932.
- D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.
- E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter unless otherwise indicated.
- F. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- G. Sealant: As specified in Section 07 92 00 "Joint Sealants."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Reject plaster materials that are wet or moisture damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster in accordance with ASTM C926.

3.03 INSTALLATION, GENERAL

- A. Fire-Resistance-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.
- B. Sound-Attenuation Blankets: Where indicated on Drawings, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
- C. Sealant: Where indicated on Drawings, seal joints between edges of plasterwork and abutting construction with sealant.

3.04 INSTALLATION OF METAL LATH

- A. Metal Lath: Install in accordance with ASTM C1063.
 - 1. Partition Framing and Vertical Furring: Install **[flat diamond-mesh] [welded-wire] [woven-wire]** lath.
 - 2. Flat-Ceiling and Horizontal Framing: Install **[flat diamond-mesh] [3/8-inch rib] [welded-wire] [woven-wire]** lath.
 - 3. Curved-Ceiling Framing: Install **[flat diamond-mesh] [welded-wire] [woven-wire]** lath.
 - 4. On Solid Surfaces, Not Otherwise Furred: Install **[self-furring diamond-mesh] [welded-wire] [woven-wire]** lath.

3.05 INSTALLATION OF ACCESSORIES

- A. Install in accordance with ASTM C1063 and at locations indicated on Drawings.
- B. Reinforcement for External (Outside) Corners:
 - 1. Install **[lath-type, external-corner reinforcement] [cornerbead]** at exterior locations.
 - 2. Install cornerbead at interior locations.
- C. Control Joints: Locate as approved by Architect for visual effect and as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft..
 - b. Horizontal and Other Nonvertical Surfaces: 100 sq. ft..
 - 2. At distances between control joints of not greater than 18 ft. o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.
 - 5. Where plastered ceiling framing or furring changes direction.
 - 6. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.
- D. Expansion Joints: Locate where expansion joints occur in supporting construction.

3.06 APPLICATION OF BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926.
 - 1. Install so that finished plaster surfaces will not deviate more than plus or minus 1/4 inch in 10 ft. from a true plane when measured by a 10-ft. straightedge placed on surface.

2. Install so finished plaster surfaces will be flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets.
- B. Bonding Compound: Apply on **[unit masonry] [and] [concrete]** substrates for direct application of plaster.
- C. Moisture cure for a minimum of 48 hours must be provided. Environmental conditions such as low humidity or windy conditions may dictate additional curing.
- D. Wall/Vertical Base Coats:
1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats having 3/4-inch total thickness.
 2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in **[3/8-inch thickness on masonry] [1/4-inch thickness on concrete]**.
- E. Ceiling/Horizontal Base Coats:
1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats with **[1/2-inch total thickness] [3/4-inch total thickness for metal lath on concrete]**.
 2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in 1/4-inch thickness on concrete.
- 3.07 APPLICATION OF CEMENT PLASTER FINISH COATS
- A. General: Comply with ASTM C926.
1. Do not deviate more than plus or minus 1/4 inch in 10 ft. from a true plane in finished plaster surfaces when measured by a 10-ft. straightedge placed on surface.
 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, groove finish coat at junctures with metal.
 3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Plaster Finish Coats: Apply to provide **[float] [dash] [scraped trowel-textured] [skip trowel-textured] [brocade (knock-down dash)] [trowel sweep] [combed] [sacked (California mission)] [English] [marblecrete]** <Insert requirements> finish to match Architect's sample.
- C. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, in accordance with manufacturer's written instructions.
- D. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.
- E. Concealed Interior Plasterwork:
1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.

2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.08 REPAIR

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.09 CLEANING

- A. Remove temporary protection and enclosure of other work after plastering is complete.
- B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.
- C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION

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SECTION 09 28 13

CEMENTITIOUS BACKING BOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Waterproof board for [interior and exterior] [restroom] [countertops] [shower] [utility room] [steam room] [swimming pool] [mechanical rooms] [wet areas] where [tiling] is being installed.
 - a. Install at [floor] [wall] [ceilings]
 - 2. Fasteners and joint tape.
- B. Related requirements: Other Section of Division 09 for shower pans and ceramic tile.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing:
- B. Pre-installation meeting:

1.03 SUBMITTALS

- A. Data: Manufacturer Product Data for materials specified below.

1.04 JOB CONDITIONS

- A. Provide adequate ventilation to dissipate excess moisture.
- B. Illuminate work areas during installation to provide the same or greater level of illumination required to properly perform this work and as will occur in the room or space after the building is in operation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement backerboard: One of the following, 5/8-inch thick by 48-inch wide by 96-inch long cementitious fiber-mat reinforced sheathing complying with ASTM C 1325, Type A, ANSI A118.9.
 - 1. PermaBase by National Gypsum Co. (basis of design).
 - 2. Util-A-Crete by FinPan.
 - 3. Durock by US Gypsum Co.
- B. Joint reinforcement: Alkali-resistant, 2-inch wide, coated fiberglass mesh tape acceptable to the board manufacturer.

- C. Fasteners: Self-drilling, galvanized, No. 2 flat, reduced Philips head recessed with nibs by 1-1/4-inch long by Pro-Twist Construction Fasteners, or equal.
- D. Washers: 3/4-inch diameter, countersunk, stainless steel washer for use where panels abut over a framing member.
- E. Tape bonding materials: Latex-modified Portland cement mortar as specified in Section 09 31 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at the site.
- B. Correct detrimental conditions before proceeding with installation.

3.02 INSTALLATION

- A. General:
 - 1. Comply with the board manufacturer instructions and the following.
 - 2. Use longest possible board length in all cases.
 - 3. Install boards with vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 4. Refer to, and comply with, Section 09 30 00 for allowable tolerances.
- B. Boards: Support edges of board parallel to framing continuously.
 - 1. Precut panels and make accurate cutouts for penetrations.
 - 2. Install boards with a 3/8-inch gap where non-load-bearing construction they abut structural elements.
 - 3. To prevent wicking, install boards with a 1/4-inch gap where they abut materials that might retain moisture.
 - 4. Attach board at 8 inches o.c.; set fasteners back 3/8-inch minimum from edges. Drive fasteners so heads bear tightly against face of boards but do not cut into facing.
 - 5. Pre-fill gap between boards with bonding material then embed 2-inch mesh tape and smooth material over joint and corner.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Tile backing panels.
4. Texture finishes.
5. Acoustical Sealant.

B. Related Requirements:

1. Section 06 16 00 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 07 92 00 "Joint Sealants" for joint sealants installed in gypsum board assemblies.
3. Section 09 21 16 "Gypsum Board Shaft Wall Systems" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Section 09 22 16 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
5. Section 09 30 13 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Flexible gypsum board.
4. Gypsum ceiling board.
5. Foil-backed gypsum board.
6. Abuse-resistant gypsum board.
7. Impact-resistant gypsum board.

8. Mold-resistant gypsum board.
 9. Gypsum board, Type C.
 10. Glass-mat interior gypsum board.
 11. Acoustically enhanced gypsum board.
 12. Skim-coated gypsum board.
 13. Exterior gypsum soffit board.
 14. Glass-mat gypsum sheathing board.
 15. Glass-mat, water-resistant backing board.
 16. Cementitious backer units.
 17. Water-resistant gypsum backing board.
 18. Interior trim.
 19. Exterior trim.
 20. Aluminum trim.
 21. Joint treatment materials.
 22. Laminating adhesive.
 23. Sound-attenuation blankets.
 24. Acoustical Sealant.
 25. Textured finishes.
- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
 2. Textured Finishes: **[Manufacturer's standard size]** <Insert size> for each textured finish indicated and on same backing indicated for Work.
- D. Samples for Initial Selection: For each type of **[trim accessory]** **[and]** **[textured finish]** indicated.
- E. Samples for Verification: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

2. Textured Finishes: **[Manufacturer's standard size] <Insert size>** for each textured finish indicated and on same backing indicated for Work.

1.03 MOCKUPS

- A. Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Build mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each texture finish indicated.
 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 3. Simulate finished lighting conditions for review of mockups.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.05 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or blotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.03 GYPSUM BOARD, GENERAL

Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.04 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: [Tapered] [Tapered and featured (rounded or beveled) for prefilling].
- B. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: [Tapered] [Tapered and featured (rounded or beveled) for prefilling].
- C. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
 - 1. Thickness: 1/4 inch.
 - 2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C1396/C1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- E. Foil-Backed Gypsum Board: ASTM C1396/C1396M.
 - 1. Core: [As indicated on Drawings] **[3/8 inch, regular type]** **[1/2 inch, regular type]** **[5/8 inch, Type X]** [Type C as required by fire-resistance-rated assembly indicated on Drawings].
 - 2. Long Edges: [Tapered] [Tapered and featured (rounded or beveled) for prefilling].
- F. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested in accordance with ASTM C1629/C1629M.
 - 1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]**.

2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 3. Indentation: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 5. Long Edges: Tapered.
 6. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- G. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested in accordance with ASTM C1629/C1629M.
1. Core: **[As indicated on Drawings]** **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
 2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 3. Indentation: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements.
 5. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1]** **[Level 2]** **[Level 3]** requirements in accordance with test in Annex A1.
 6. Long Edges: Tapered.
 7. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- H. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: **[As indicated on Drawings]** **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- 2.05 SPECIALTY GYPSUM BOARD
- A. Gypsum Board, Type C: ASTM C1396/C1396M. Manufactured to have increased fire-resistive capability.
1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
 2. Long Edges: Tapered.
- B. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.

1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[1/2 inch, Type C]** **[5/8 inch, Type X]** **[5/8 inch, abuse resistant]**.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- C. Acoustically Enhanced Gypsum Board: ASTM C1766. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[1/2 inch, Type X]** **[5/8 inch, regular type]** **[5/8 inch, Type X]** **[1-3/8 inch, regular type]**.
 2. Long Edges: Tapered.
- D. Skim-Coated Gypsum Board: ASTM C1396/C1396M. Manufactured with a factory-applied skim coat.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
 2. Long Edges: Tapered.
- 2.06 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS
- A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
- B. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
- 2.07 TILE BACKING PANELS
- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]**.
 2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
1. Thickness: **[1/4 inch]** **[1/2 inch]** **[5/8 inch]** [As indicated on Drawings].
 2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
- C. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.
1. Core: [As indicated on Drawings] **[1/2 inch, regular type]** **[5/8 inch, Type X]** [Type C as required by fire-resistance-rated assembly indicated on Drawings].

2.08 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: [Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet] [Galvanized or aluminum-coated steel sheet or rolled zinc] [Plastic] [Paper-faced galvanized-steel sheet].
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
 - h. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches high.
 - i. Base-of-Wall PVC Moisture Barrier Trim: Extruded PVC, [1/2 inch] [1-3/4 inch] [3-1/2 inch] high.

B. Exterior Trim: ASTM C1047.

1. Material: [Hot-dip galvanized-steel sheet, plastic, or rolled zinc] <Insert material>.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
2. Finish: [Corrosion-resistant primer compatible with joint compound and finish materials specified] <Insert requirements for Class II anodic finishes and factory-painted, baked-enamel finishes>.

2.09 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

- B. Joint Tape:
1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints **[, rounded or beveled panel edges,]** and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use **[setting-type taping] [drying-type, all-purpose]** compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
 4. Finish Coat: For third coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
 5. Skim Coat: For final coat of Level 5 finish, use **[setting-type, sandable topping compound] [drying-type, all-purpose compound] [high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish].**
- D. Joint Compound for Exterior Applications:
1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
- E. Joint Compound for Tile Backing Panels:
1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 2. Cementitious Backer Units: As recommended by backer unit manufacturer.
 3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
 4. <Insert products>.

2.10 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant:
 - 1. Bulk sealant for closing small openings and joints up to a maximum of one-inch wide. Sealant backed with glass fiber packing, compressible joint filler or resilient backer rod. Do not use acetoxysilicone sealant where it might contact copper pipes.
 - a. Products:
 - 1) Pecora Corp.: AC-20.
 - 2) US Gypsum Co.: Sheetrock Acoustical Sealant.
 - 3) Tremco, Inc.: Acoustical Sealant.
 - 4) OSI Sealants: Henkel Corporation: OSI Pro-Series SC-175 Acoustical Sound Sealant.
 - 5) Or equal.
 - 2. Fire-barrier (acoustical) putty:
 - a. For closing large openings and joints typically over one inch wide. Applied full depth or backed with a dense safing, as detailed.
 - b. Non-shrinking, highly-adhesive, minimum 40-pcf density fire-barrier putty.
 - c. Products:
 - 1) Series SSP Firestop Putty and Putty Pads by Specified Technologies Inc.
 - 2) Nelson FSP Firestop Intumescent Putty by Chargar Corp.
 - 3) Fiberfrax Fyre Putty by Unifrax.
 - 4) Hilti CP 617 and CP 617L, intumescent moldable firestop putty for electrical outlet boxes.
 - 3. Foamed-in-place silicone sealant:
 - a. For closing electrical ducts and cable trays where they penetrate constructions. Apply full depth of construction between permanent or temporary dams.
 - b. Fire-resistant, minimum 17-pcf density, foamed-in-place silicone sealant.
 - 1) Products:

- a) Fire Barrier 2001 Silicone RTV Foam by 3M Fire Barrier Products Division.
 - b) Or equal.
- c. Fire-resistive acoustic foam tape:
- 1) "Norseal V740FR" compressible, closed cell polyvinyl chloride foam tape with pressure sensitive adhesive by Saint Gobain.
 - 2) Or equal.
 - 3) Provide one-inch wide by not less than 1/4-inch thick, self-extinguishing, 6 pcf density UL-listed acoustical foam tape.
 - 4) Furnish tape in rolls with protective release liner on non-adhesive face.
- F. Sealant: As specified in Section 07 92 00 "Joint Sealants."
- G. Acoustic Pads
- 1. Use: For sealing the backs and sides of standard electrical back boxes. Select size to completely cover the box and overlap wall facing material at least one-inch.
 - 2. Fire-rated assemblies:
 - a. Flamesafe FSP 1077 Putty Pads by WR Grace & Co.
 - b. Putty Pads by Specified Technologies Inc.
 - c. Hilti CP617 Putty Pads by Hilti.
 - d. 3M Fire Barrier Moldable Putty Pads by RectorSeal.
 - e. Putty Pads by International Protective Coatings.
 - 3. Elsewhere:
 - a. Type FSP Firestop Putty Pads by Nelson Electric.
 - b. Lowry's Outlet Box Pads by Harry A. Lowry & Associates.
 - c. Sound Pad #68 by L.H. Dottie Co.
 - 4. Self-adhesive sponge neoprene pads:
 - a. For providing a compressible filler and acoustical seal in the gaps of slip joints. Set in place with 10 to 15 percent compression. Airtight splices work in length-wise direction.
 - b. Closed-cell sponge or foam neoprene of 8- to 12-pcf density, self-adhesive on one side, thicknesses and widths as required.
 - c. Products:
 - 1) Type V760 Norseal Foam Sealants by American Saint-Gobain.
 - 2) DS Brown Co.
 - 3) Or equal.
 - 5. Felt-lined metal sleeves:

- a. For sealing around pipe, hanger rod or other round element penetrating a construction. Inside sleeve diameter to equal outside diameter of penetrating element. Exposed end of sleeve closed with acoustical sealant.
 - 1) Products:
 - a) Pipe Isolator by Eleen.
 - b) P-R Isolator by Potter-Roemer.
 - c) Trisolator by Stoneman Engineering.
 6. Self-adhesive bubble gaskets:
 - a. To seal around the edge of an operating access panels. Typically set on jamb or head frame or stop to act as a compression seal.
 - b. Nominal 1/4-inch by 1/2-inch compressible bulb of silicone rubber or polyprene with self-adhesive on one side.
 - c. Products:
 - 1) 5050 Self-Adhesive Gasket by National Guard Products.
 - 2) S88D or S88W Silicoseal by Pemko.
 - 3) 797 or 797W by Reese Enterprises.
 - 4) Or equal.
 - H. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."
 - I. Vapor Retarder: As specified in **[Section 07 27 15 "Non-Bituminous Self-Adhered Sheet Air Barriers.]" [Section 07 27 26 "Fluid-Applied Membrane Air Barriers.]**
- 2.11 TEXTURE FINISHES
- A. Primer: As recommended by textured finish manufacturer.
 - B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested in accordance with ASTM E84.
 1. Texture: **[Fine] [Medium] [Coarse]**.
 - C. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.
 1. Texture: **[Light spatter] [Spatter knock-down] <Insert texture>**.
 - D. Non-Aggregate Finish: Premixed, vinyl texture finish for spray application.
 1. Texture: **[Orange peel] [Spatter] [Spatter knock-down] <Insert texture>**.
 - E. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.
 1. Application Thickness: **[1/2 inch] <Insert dimension>**.
 2. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- a. Flame-Spread Index: **[25]** <Insert value> or less.
 - b. Smoke-Developed Index: **[50]** **[450]** <Insert value> or less.
3. NRC: **[0.55]** <Insert NRC> in accordance with ASTM C423.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.03 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: [As indicated on Drawings] [Vertical surfaces unless otherwise indicated].
 - 2. Type X: [As indicated on Drawings] [Where required for fire-resistance-rated assembly] [Vertical surfaces unless otherwise indicated] <Insert requirements>.
 - 3. Flexible Type: [As indicated on Drawings] [Apply in double layer at curved assemblies].
 - 4. Ceiling Type: [As indicated on Drawings] [Ceiling surfaces].
 - 5. Foil-Backed Type: [As indicated on Drawings] <Insert requirements>.
 - 6. Abuse-Resistant Type: [As indicated on Drawings] <Insert requirements>.
 - 7. Impact-Resistant Type: [As indicated on Drawings] <Insert requirements>.
 - 8. Mold-Resistant Type: [As indicated on Drawings] <Insert requirements>.
 - 9. Type C: [As indicated on Drawings] [Where required for specific fire-resistance-rated assembly indicated].
 - 10. Glass-Mat Interior Type: [As indicated on Drawings] <Insert requirements>.
 - 11. Acoustically Enhanced Type: [As indicated on Drawings] <Insert requirements>.
 - 12. Skim-Coated Type: [As indicated on Drawings] <Insert requirements>.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.

2. On partitions/walls, apply gypsum panels **[vertically (parallel to framing)] [horizontally (perpendicular to framing)]** unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 4. Fastening Methods: Fasten base layers **[and face layers separately to supports with screws] [with screws; fasten face layers with adhesive and supplementary fasteners]**.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- E. Curved Surfaces:
1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
 2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.
- 3.04 INSTALLATION OF EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS
- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

3.05 INSTALLATION OF TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at **[showers, tubs, and where indicated on Drawings] [locations indicated to receive tile]**. Install with 1/4-inch gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.11, at **[showers, tubs, and where indicated on Drawings] [locations indicated to receive tile]**.
- C. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.
- D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.06 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints **[at locations indicated on Drawings] [in accordance with ASTM C840 and in specific locations approved by Architect for visual effect]**.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners **[unless otherwise indicated]**.
 2. Bullnose Bead: Use **[at outside corners] [where indicated on Drawings] <Insert requirements>**.
 3. LC-Bead: Use **[at exposed panel edges] <Insert requirements>**.
 4. L-Bead: Use **[where indicated on Drawings] <Insert requirements>**.
 5. U-Bead: Use **[at exposed panel edges] [where indicated on Drawings] <Insert requirements>**.
 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners.
 2. LC-Bead: Use **[at exposed panel edges] <Insert requirements>**.
- E. Aluminum Trim: Install in locations **[indicated on Drawings] <Insert requirements>**.

3.07 INSTALLATION OF ACOUSTIC PADS

- A. Install acoustic pads behind all recessed boxes in walls that have acoustical insulation in their stud cavities.
- B. Clean the contact area of loose and foreign material in accordance with the pad manufacturer's instructions.
- C. Verify that all unused knockouts are plugged before installing the pad.
- D. Center the pad and cover the back and sides of all electrical, telephone and CATV boxes in sound-insulated walls with the acoustical pad.
- E. Mold around conduits and cables entering the box.
- F. Mold pads tightly to the boxes and to the adjacent surfaces.

3.08 ACOUSTIC SEALANT

- A. Comply with ASTM C 919 and the following.
- B. Clean space to be caulked of debris, dust and powdered materials which would prevent the sealant from adhering properly.
- C. Seal openings between gypsum board and the perimeter of items penetrating gypsum board, such as electrical boxes, continuously using sealant specified.
- D. Seal openings between the gypsum board and floors and ceilings along sound-insulated walls continuously, and along those intersecting walls for a minimum distance of 3-foot from insulated walls. When multiple layers occur, seal the perimeter of each layer continuously.
- E. Seal gypsum board edges in contact with door frames continuously.

3.09 FINISHING OF GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints **[, rounded or beveled edges,]** and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: **[Panels that are substrate for tile] [Panels that are substrate for acoustical tile] [Where indicated on Drawings] <Insert locations>.**
 - 3. Level 3: **[Where indicated on Drawings] <Insert locations>.**

4. Level 4: [At panel surfaces that will be exposed to view unless otherwise indicated] <Insert locations>.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
 5. Level 5: [Where indicated on Drawings] <Insert locations>.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- 3.10 APPLICATION OF TEXTURE FINISHES
- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
 - B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture [**matching approved mockup and**] free of starved spots or other evidence of thin application or of application patterns.
 - C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written instructions.
- 3.11 PROTECTION
- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
 - B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
 - C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

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SECTION 09 30 13

CERAMIC TILING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Quarry tile.
2. Porcelain tile.
3. Ceramic mosaic tile.
4. Glazed wall tile.
5. Thresholds.
6. Tile backing panels.
7. Waterproof membranes.
8. Crack isolation membranes.
9. Setting material.
10. Grout materials.

B. Related Requirements:

1. [Section 071326 "Self-Adhering Sheet Waterproofing"] for waterproofing under thickset mortar beds.
2. Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.
3. Section 092400 "Cement Plastering" for scratch coat for thickset mortar setting-bed installations.
4. Section 092613 "Gypsum Veneer Plastering" for cementitious backer units.
5. Section 092900 "Gypsum Board" for tile backing panels.
6. Section 093023 "Glass Tiling."
7. Section 093033 "Stone Tiling."
8. Section 096340 "Stone Flooring" for stone thresholds.

1.02 DEFINITIONS

- A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Large Format Tile: Tile with at least one edge 15 inches (381 mm) or longer.
- D. Module Size: Actual tile size plus joint width indicated.

1.03 DEFINITIONS

- A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Large Format Tile: Tile with at least one edge 15 inches or longer.
- D. Module Size: Actual tile size plus joint width indicated.

1.04 PRE-INSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.
 2. Review tile diagram layout.

1.05 SUBMITTALS

- A. Product Data:
1. Quarry tile.
 2. Porcelain tile.
 3. Ceramic mosaic tile.
 4. Glazed wall tile.
 5. Thresholds.
 6. Tile backing panels.
 7. Waterproof membranes.
 8. Crack isolation membranes.
 9. Setting material.
 10. Grout materials.
- B. Shop Drawings:
1. Show locations, plans, and elevations, of each type of tile and tile pattern.
 2. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces. Show thresholds.
 3. Show edge transitions..
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection or shade variation.
- D. Samples for Verification:
1. Full-size units of each type and composition of tile and for each color and finish required. **[For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.]** **[For tile with aesthetic classification V3 or V4, provide 12 tiles from same production run.]**
 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least **[12 inches square] [36 inches square] <Insert size>**, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 3. Full-size units of each type of trim and accessory **[for each color and finish required]**.
 4. Stone thresholds in 6-inch lengths.
 5. Metal flooring transitions 6-inch lengths.
- E. Qualification Data: For Installer.
- F. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- G. Product Certificates: For each type of product, including product use classification.
- H. Product Test Reports:

1. Tile-setting and -grouting products.
2. Certified porcelain tile.
3. Slip-resistance test reports from qualified independent testing agency.

I. Field Quality-Control Reports: Water test reports of membrane in wet areas.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: [Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.]
 - a. <Insert, in separate subparagraphs, tile-type designation or description and quantity required for each category of tile for which extra material is required>.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is [a Five-Star member of the National Tile Contractors Association] [or] [a Trowel of Excellence member of the Tile Contractors' Association of America].
2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
3. Installer employs only [Ceramic Tile Education Foundation Certified Installers] [or] [installers recognized by the U.S. Department of Labor as Journeyman Tile Layers] for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of **[mud floors] [mud walls] [membranes] [shower receptors] [and] [large format tile]**.

1.08 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of **[each type of]** floor tile installation.
2. Build mockup of **[each type of]** wall tile installation.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in "Referenced Standards" Article in the Evaluations and manufacturer's written instructions.

1.11 WARRANTY

- A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to repair and replace defective installation areas, material, and labor that fail under normal usage within specified warranty period.
 - 1. Warranty Period: **[Five years] [10 years] [25 years] [Lifetime]** from date of Product Purchase.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 SOURCE LIMITATIONS

- A. Tile: Obtain **[tile of each type and color or finish] [tile of each type] [tile of each color or finish] [tile]** from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
 - 2. See College Campus Standards for preferred tile systems.
- B. Tiling System: Obtain system products from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified portland cement and aggregate, from single manufacturer.
 - 2. Obtain underlayment from manufacturer of setting and grouting materials.
 - 3. Obtain waterproof membrane, crack isolation, and other required membranes from manufacturer of setting and grouting materials.
 - 4. Obtain joint sealants from manufacturer of setting and grouting materials.
 - 5. Obtain large format adhesives and spacers for installation.
- C. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Stone thresholds.
 - 2. Backer units.

2.03 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard Grade requirements **[unless otherwise indicated]**.

- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation **[in swimming pools] [on exteriors] [or] [in wet areas]**, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.04 QUARRY TILE

- A. Quarry Tile Type <Insert drawing designation>: **[Unglazed] [Glazed] [Chemical resistant]**.
 - 1. Face Size: **[3 by 3 inches] [4 by 4 inches] [6 by 3 inches] [6 by 6 inches] [8 by 3-7/8 inches] [8 by 8 inches]** <Insert dimensions>.
 - 2. Thickness: **[3/8 inch] [1/2 inch] [3/4 inch]**.
 - 3. Wearing Surface: **[Nonabrasive, smooth] [Abrasive aggregate embedded in surface]** <Insert description>.
 - 4. Product Use Classification: **[Interior, Dry (ID)] [Interior, Wet (IW)] [Interior, Wet Plus (IW+)] [Exterior, Wet (EW)] [Oil/Greases (O/G)]**.
 - 5. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
 - a. <Insert chemical reagent>.
 - 6. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and pattern>.
 - 7. Grout Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.
 - 8. Precoat with temporary protective coating.
 - 9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable **[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base: Coved [with surface bullnose top edge], face size **[6 by 6 inches] [8 by 3-7/8 inches]** <Insert dimensions>.
 - b. Wainscot Cap: Surface bullnose, face size **[6 by 6 inches] [8 by 3-7/8 inches]** <Insert dimensions>.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

2.05 PORCELAIN TILE

- A. Porcelain Tile Type <Insert drawing designation>: [Unglazed] [Glazed] [Chemical resistant].
1. Certification: Tile certified by the Porcelain Tile Certification Agency.
 2. Face Size: [3 by 3 inches] [4 by 4 inches] [6 by 6 inches] [7-3/4 by 3-7/8 inches] [7-7/8 by 7-7/8 inches] [11-13/16 by 11-13/16 inches] <Insert dimensions>.
 3. Face Size Variation: Rectified.
 4. Thickness: [1/4 inch] [3/8 inch] [1/2 inch].
 5. Product Use Classification: [Interior, Dry (ID)] [Interior, Wet (IW)] [Interior, Wet Plus (IW+)] [Exterior, Wet (EW)] [Oil/Greases (O/G)].
 6. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
 - a. <Insert chemical reagent>.
 7. Tile Color, Glaze, and Pattern: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color, glaze, and pattern>.
 8. Grout Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 9. Precoat with temporary protective coating.
 10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**]. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size [same as adjoining flat tile] <Insert size>.
 - b. Wainscot Cap: Surface bullnose, module size [same as adjoining flat tile] <Insert size>.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size [same as adjoining flat tile] <Insert size>.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch across nominal 4-inch dimension.

2.06 CERAMIC MOSAIC TILE

- A. Ceramic Mosaic Tile Type <Insert drawing designation>: [Unglazed] [Glazed] [Chemical resistant].
1. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
 2. Module Size: [1 by 1 inch] [1 by 2 inches] [2 by 2 inches] <Insert dimensions>.
 3. Thickness: 1/4 inch.
 4. Face: [Plain] [Pattern of design indicated,] with cushion edges.
 5. Surface: [Smooth, without] [Slip resistant, with] abrasive admixture.
 6. Product Use Classification: [Interior, Dry (ID)] [Interior, Wet (IW)] [Interior, Wet Plus (IW+)] [Exterior, Wet (EW)] [Oil/Greases (O/G)].
 7. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
 - a. <Insert chemical reagent>.

8. Tile Color and Pattern: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and pattern>.
9. Grout Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable **[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cove: Cove, module size **[1 by 1 inch] [2 by 1 inch]** <Insert dimensions>.
 - b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[1 by 1 inch] [2 by 1 inch]** <Insert dimensions>.
 - c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size **[1 by 1 inch] [2 by 1 inch] [2 by 2 inches]** <Insert dimensions>.
 - d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[1 by 1 inch] [2 by 1 inch]** <Insert dimensions>.
 - e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size **[1 by 1 inch] [2 by 1 inch] [2 by 2 inches]** <Insert dimensions>.
 - f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
 - g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size **[1 by 1 inch] [2 by 1 inch]** <Insert dimensions>.
 - h. External Corners for Thinset Mortar Installations: Surface bullnose, module size **[1 by 1 inch] [2 by 1 inch] [2 by 2 inches]** <Insert dimensions>.
 - i. Internal Corners:
 - 1) Cove, module size **[1 by 1 inch] [2 by 1 inch]** <Insert dimensions>.
 - 2) Field-buttet square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.
 - j. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch across nominal 4-inch dimension.

2.07 GLAZED WALL TILE

- A. Glazed Wall Tile Type <Insert drawing designation>:
 1. Module Size: **[4-1/4 by 4-1/4 inches] [6 by 4-1/4 inches] [6 by 6 inches]** <Insert dimensions>.
 2. Face Size Variation: Rectified.
 3. Thickness: 5/16 inch.
 4. Tile Color and Pattern: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and pattern>.
 5. Grout Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 6. Mounting:
 - a. Factory, back mounted.

- b. PregROUTED sheets of tiles are factory assembled and grouted with manufacturer's standard white silicone rubber.
- 7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable **[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base for Portland Cement Mortar Installations: Coved, module size **[4-1/4 by 4-1/4 inches] [6 by 6 inches] [6 by 3-3/4 inches]** <Insert dimensions>.
 - b. Base for Thinset Mortar Installations: Straight, module size **[4-1/4 by 4-1/4 inches] [6 by 6 inches] [6 by 2 inches]** <Insert dimensions>.
 - c. Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size **[4-1/4 by 4-1/4 inches] [6 by 6 inches] [6 by 2 inches]** <Insert dimensions>.
 - d. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size **[4-1/4 by 4-1/4 inches] [6 by 6 inches] [6 by 2 inches]** <Insert dimensions>.
 - e. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
 - f. External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 3/4 inch unless otherwise indicated.
 - g. External Corners for Thinset Mortar Installations: Surface bullnose; same size as adjoining flat tile.
 - h. Internal Corners: Field-buttet square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.
- B. Accessories: Provide vitreous china accessories of type and size indicated; suitable for installing by same method as used for adjoining wall tile.
 - 1. One soap holder **[with grab handle]** for each shower and tub indicated.
 - 2. One paper holder at each water closet.
 - 3. Color and Finish: **[Match adjoining glazed wall tile] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [White, bright glaze]** <Insert color and finish>.

2.08 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
- B. Granite Thresholds: ASTM C615/C615M, with **[polished] [honed] <Insert finish>** finish.
 - 1. Description:
 - a. Uniform, [fine] [medium]-grained, [white] [gray] [black] <Insert color> stone without veining.
 - b. Match Architect's sample.
 - c. Provide **[one of]** the following:
 - 1) <Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>.

- C. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of **[10] [12]** in accordance with ASTM C1353/C1353M or ASTM C241/C241M and with honed finish.

1. Description:

- a. Uniform, fine- to medium-grained white stone with gray veining.
- b. Match Architect's sample.
- c. Provide **[one of]** the following:

- 1) **<Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>**.

- D. Slate Thresholds: ASTM C629/C629M, Classification **[I Exterior] [II Interior]**, with fine, even grain and honed finish.

1. Description:

- a. Uniform, **[black] [blue-black] [gray] [blue-gray] [green]** **<Insert color>** stone **[and unfading]**.
- b. Match Architect's sample.
- c. Provide **[one of]** the following:

- 1) **<Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>**.

- E. Solid Surface: Homogeneous-filled plastic resin complying with ISFA-02-01.

1. Description:

- a. Type: Provide **[Standard] [Special Purpose]** type.
- b. Colors and Patterns: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range]**.

2.09 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges in maximum lengths available to minimize end-to-end butt joints.

1. Thickness: **[1/4 inch] [1/2 inch] [5/8 inch]** **[As indicated on Drawings]**.
2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

- B. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Core: **[As indicated on Drawings] [1/2 inch, regular type] [5/8 inch, Type X] [Type C as required by fire-resistance-rated assembly indicated on Drawings]**.

- C. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Core: **[As indicated on Drawings] [1/2 inch, regular type] [1/2 inch, Type C] [5/8 inch, Type X] [5/8 inch, abuse resistant]**.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

- D. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Core: [As indicated on Drawings] [1/2 inch, regular type] [5/8 inch, Type X].
2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.10 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product [, **selected from the following,**] that complies with ANSI A118.10 [**and ANSI A118.12**] and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Waterproof Membrane, Sheet: Polyethylene sheet faced on one or both sides with polyester fabric.
 1. Nominal Thickness: [0.02 inch] [0.03 inch] [0.008 inch] <Insert thickness>.
- C. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer [**with continuous fabric reinforcement**].

2.11 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product [, **selected from the following,**] that complies with ANSI A118.12 for [**standard performance**] [**high performance**] and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Crack Isolation Membrane, Polyethylene Sheet: Polyethylene faced on both sides with polyester fabric.
- C. Crack Isolation Membrane, Asphaltic Sheet: Self-adhering, modified-asphalt sheet [**with fabric reinforcement facing**].
- D. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer [**with continuous fabric reinforcement**].

2.12 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
 2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A1064/A1064M except for minimum wire size.
 3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.
 - a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
 - b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
 - c. Configuration over Studs and Furring: Flat.
 - d. Configuration over Solid Surfaces: Self-furring.
 - e. Weight: [2.5 lb/sq. yd.] [3.4 lb/sq. yd.].

4. Latex Additive: **[Manufacturer's standard] [acrylic resin] [or] [styrene-butadiene-rubber]** water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.1.
- C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.
 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.
- D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.
1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.
 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.15.
- E. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thinset): ANSI A118.11.
1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.
- F. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.
1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.
- G. Organic Adhesive: ANSI A136.1, **[Type I] [Type II]**.
- H. Chemical-Resistant Furan Mortar: ANSI A118.5, with **[carbon] <Insert material>** filler.
- I. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- J. Standard Cement Grout: ANSI A118.6.
- K. High-Performance Tile Grout: ANSI A118.7.
1. Polymer Type:
 - a. Dry, redispersible form, prepackaged with other dry ingredients.
 - b. Liquid-latex form for addition to prepackaged dry-grout mix.

- L. Water-Cleanable Epoxy Grout: ANSI A118.3[**with a VOC content of 65 g/L or less**].
 - 1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.
- M. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.
 - 1. MAPEI, LATRICRETE, or Equal.
- N. Grout for Pre-grouted Tile Sheets: Same product used in factory to pre-grout tile sheets.

2.13 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.
- B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, 4.0 mils thick.
- C. Metal Flooring Transitions: Profile designed specifically for flooring applications; height to match tile and setting-bed thickness.
 - 1. Description: [L-shaped] [Square] <Insert profile>.
 - 2. Material and Finish: Metallic or combination of metal and PVC or neoprene base; [chrome-plated brass] [polished chrome anodized aluminum] [polished nickel anodized aluminum] [color-coated aluminum] [half-hard brass] [white zinc alloy] <Insert finish> exposed-edge material.
 - a. Color: [Brown] [White] [Gray] <Insert color>.
- D. Metal Edge Trim: Profile designed for wall terminations and edge protection.
 - 1. Description: [L-shaped] [Square] [Beveled] <Insert profile>.
 - 2. Terminations: [End caps] [Inside corners] [Outside corners] matching edge-protection profile.
 - 3. Material and Finish: [Chrome-plated brass] [Polished chrome anodized aluminum] [Polished nickel anodized aluminum] [Color-coated aluminum] <Insert finish> exposed-edge material.
 - a. Color: [Brown] [White] [Gray] <Insert color>.
- E. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.
- F. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- G. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 2. Verify that concrete substrates for tile floors installed with **[adhesives] [bonded mortar bed] [or] [thinset mortar]** comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with **[adhesives] [or] [thinset mortar]** with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped 1/4 inch per foot toward drains.
- D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- E. Substrate Flatness:
1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.
 2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.
- F. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.
- B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- D. Mix mortars and grouts to comply with "Referenced Standards" Article in the Evaluations and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.
- E. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Exterior tile floors and walls.
 - b. Tile floors in wet areas.
 - c. Tile swimming pool decks.
 - d. Tile floors in laundries.
 - e. Tile floors consisting of tiles 8 by 8 inches or larger.
 - f. Tile floors consisting of rib-backed tiles.
 - 2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
 - 3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
 - 4. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
 - 5. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
 - 6. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets, so joints between sheets are not apparent in finished Work.

- b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
 7. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- G. Thresholds: Install stone and solid surface thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in **[modified dry-set] [improved modified dry-set]** mortar (thinset).
 2. Do not extend [cleavage membrane] [waterproof membrane] [or] [crack isolation membrane] under thresholds set in [standard dry-set] [modified dry-set] [or] [improved modified dry-set] mortar. Fill joints between such thresholds and adjoining tile set on [cleavage membrane] [waterproof membrane] [or] [crack isolation membrane] with elastomeric sealant.
- H. Metal Flooring Transitions: Install **[at locations indicated] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated]**.
- I. Metal Wall Trim: Install at locations indicated on Drawings.
- J. Grout Sealer: Apply grout sealer to **[cementitious] grout joints [in tile floors]** in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.04 FIELD QUALITY CONTROL

- A. Water Test:
 1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.
 - a. Perform test after 24 hours of waterproof membrane installation.
 - b. Insert test plug in drain or waste line.
 - c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
 - d. Check for leaks after 24 hours.
 2. Test to be witnessed by **[Inspector of Record] [Architect] [authorities having jurisdiction]** <Insert names or titles of witnesses>.
- B. Nonconforming Work:

1. Waterproof membrane will be considered defective if water level has dropped.
2. Remove and replace defective components and retest.

3.05 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 1. Remove grout residue from tile as soon as possible.
 2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.06 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.07 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 1. TCNA F111 **<Insert designation>**: Method **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**. Cement mortar bed (thickset) installed over cleavage membrane.
 - a. Ceramic Tile Type: **<Insert tile-type designation>**.
 - b. Bond Coat for Cured-Bed Method: **[Dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
 - c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement]** grout.
 - d. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** **<Insert width>**.
 - e. Movement Joints: Types located on Drawings.
 2. TCNA F125-Full **<Insert designation>**: Thinset mortar on crack isolation membrane.
 - a. Ceramic Tile Type: **<Insert tile-type designation>**.
 - b. Thinset Mortar: **[Modified dry-set] [Improved modified dry-set]** mortar.
 - c. Grout: **[Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy]** grout.

- d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
- B. Interior Floor Installations, Wood Subfloor:
- 1. TCNA F141 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) installed over cleavage membrane [over waterproof membrane].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
 - 2. TCNA F142 <Insert designation>: Organic adhesive on plywood underlayment.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy] grout.
 - c. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - d. Movement Joints: Types located on Drawings.
- C. Interior Radiant Heat Floor Installations, Concrete Subfloor:
- 1. TCNA RH110 <Insert designation>: Thinset mortar [on crack isolation membrane]; hydronic piping installed in concrete.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.

2. TCNA RH115 **<Insert designation>**: Thinset mortar; electric radiant system encapsulated in thinset mortar.
 - a. Ceramic Tile Type: **<Insert tile-type designation>**.
 - b. Thinset Mortar: **[Modified dry-set] [Improved modified dry-set]** mortar.
 - c. Grout: **[Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy]** grout.
 - d. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** **<Insert width>**.
 - e. Movement Joints: Types located on Drawings.

- D. Interior Radiant Heat Floor Installations, Wood Subfloor:
 1. TCNA RH130 **<Insert designation>**: Thinset mortar on exterior-glue plywood; electric radiant system encapsulated in thinset mortar.
 - a. Ceramic Tile Type: **<Insert tile-type designation>**.
 - b. Thinset Mortar: **[EGP (exterior glue plywood) latex-portland cement] [Modified dry-set] [Improved modified dry-set]** mortar.
 - c. Grout: **[Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy]** grout.
 - d. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** **<Insert width>**.
 - e. Movement Joints: Types located on Drawings.
 2. TCNA RH141 **<Insert designation>**: Method **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**. Cement mortar bed (thickset) installed over cleavage membrane **[and waterproof membrane]** with hydronic piping installed in mortar bed.
 - a. Ceramic Tile Type: **<Insert stone tile-type designation>**.
 - b. Bond Coat for Cured-Bed Method: **[Modified dry-set] [Improved modified dry-set]** mortar.
 - c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy]** grout.
 - d. Waterproof Membrane: **[As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane]**.
 - e. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** **<Insert width>**.
 - f. Movement Joints: Types located on Drawings.

- E. Interior Wall Installations, Masonry or Concrete:
 1. TCNA W202I **<Insert designation>**: Thinset mortar **[over waterproof membrane]**.
 - a. Ceramic Tile Type: **<Insert tile-type designation>**.
 - b. Thinset Mortar: **[Dry-set] [Modified dry-set] [Improved modified dry-set] [Water-cleanable epoxy]** mortar.

- c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA W211 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) bonded to substrate [over waterproof membrane].
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
- F. Interior Wall Installations, Wood or Metal Studs or Furring:
1. TCNA W242 <Insert designation>: Organic adhesive on gypsum board.
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - c. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - d. Movement Joints: Types located on Drawings.
2. TCNA W245 <Insert designation>: Thinset mortar on glass-mat, water-resistant gypsum backer board [over waterproof membrane].
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.

- f. Movement Joints: Types located on Drawings.
- G. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs or Furring:
- 1. TCNA B413 <Insert designation>: [Thinset mortar] [Organic adhesive] on [water-resistant gypsum] [coated glass-mat, water-resistant gypsum] backer board.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - e. Movement Joints: Types located on Drawings.
- H. Bathtub/Shower Wall Installations:
- 1. TCNA B419 <Insert designation>: Thinset mortar [over waterproof membrane] on coated glass-mat, water-resistant gypsum backer board.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
- 3.08 CHEMICAL-RESISTANT TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete:
- 1. TCNA F115 <Insert designation>: Thinset mortar [over crack isolation membrane].
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Water-cleanable epoxy] [Chemical-resistant furan].
 - d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
 - 2. TCNA F131 <Insert designation>: Water-cleanable, tile-setting epoxy.
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Grout: Water-cleanable epoxy.

- c. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** <Insert width>.
 - d. Movement Joints: Types located on Drawings.
- B. Interior Wall Installations, Masonry or Concrete:
- 1. TCNA W211 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) bonded to substrate [over waterproof membrane].
 - a. Chemical-Resistant Tile Type: **<Insert tile-type designation>**.
 - b. Bond Coat for Cured-Bed Method: **[Dry-set] [Latex-]** portland cement mortar.
 - c. Grout: Water-cleanable epoxy.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** <Insert width>.
 - f. Movement Joints: Types located on Drawings.
- C. Interior Wall Installations, Solid Backing:
- 1. TCNA W222 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. One-coat cement mortar bed (thickset) installed [over cleavage membrane] [over waterproof membrane] on solid backing.
 - a. Chemical-Resistant Tile Type: **<Insert tile-type designation>**.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: Water-cleanable epoxy.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: **[1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch]** <Insert width>.
 - f. Movement Joints: Types located on Drawings.

END OF SECTION

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SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Acoustical panels.
2. Metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with fully concealed suspension systems, stapling, or adhesive bonding.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Acoustical panels.
2. Metal suspension system.
3. Metal edge moldings and trim.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of **[full-size] [6-inch- square]** <Insert size> Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of **[6-inch-]** <Insert dimension> long Samples of each type, finish, and color.
3. Clips: Full-size **[hold-down] [impact] [and] [seismic]** clips.

E. Delegated Design Submittals: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
 - h. Microphones.
 - i. AV Accessories.
 - j. Fire and Life Safety Devices.
7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: **[1/4 inch = 1 foot] [1/8 inch = 1 foot] [1:50] [1:100]** <Insert scale>.

- B. Qualification Data: For testing agency.

- C. Product Test Reports: For each acoustical panel ceiling, for tests performed by **[manufacturer and witnessed by a qualified testing agency] [a qualified testing agency]**.

- D. Evaluation Reports: For each acoustical panel ceiling suspension system **[and anchor and fastener type]**, from ICC-ES.

- E. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials **[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Units: Full-size panels equal to **[2] <Insert number>** percent of quantity installed.
 2. Suspension-System Components: Quantity of each exposed component equal to **[2] <Insert number>** percent of quantity installed.
 3. Hold-Down Clips: Equal to **[2] <Insert number>** percent of quantity installed.
 4. Impact Clips: Equal to **[2] <Insert number>** percent of quantity installed.

1.07 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockup of typical ceiling area as indicated on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 SOURCE LIMITATIONS

- A. Source Limitations for Ceiling System: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** **<Insert requirement>**.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class **[A]** **[B]** **[C]** in accordance with ASTM E1264.
 - 2. Smoke-Developed Index: **[50]** **[450]** **<Insert value>** or less.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.04 ACOUSTICAL PANELS <Insert drawing designation>

- A. Acoustical Panel Standard: Provide manufacturer's standard panels in accordance with ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- B. Classification: Provide **[fire-resistance-rated]** panels as follows:
 - 1. Type and Form, Type III: Mineral base with painted finish; **[Form 1, nodular]** **[Form 2, water felted]** **[Form 4, cast or molded]**.
 - 2. Type and Form, Type IV Form 1: Mineral base with membrane-faced overlay; Form 1, nodular; with **[glass-fiber cloth]** **[washable vinyl-film]** overlay.
 - 3. Type and Form, Type IV Form 2: Mineral base with membrane-faced overlay; Form 2, water felted; with **[vinyl overlay on face]** **[vinyl overlay on face and back]** **[vinyl overlay on face, back, and sealed edges]** **[fiberglass-fabric overlay on face]**.
 - 4. Type and Form, Type XII: Glass-fiber base with membrane-faced overlay; **[Form 1, plastic]** **[Form 2, cloth]** **[Form 3, other]**. Binder may not contain urea formaldehyde.
 - 5. Type and Form, Type XX: High-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
 - 6. Type and Form: <Insert type and form>.

7. Pattern: [C (perforated, small holes)] [CD (perforated, small holes and fissured)] [CE (perforated, small holes and lightly textured)] [D (fissured)] [E (lightly textured)] [F (heavily textured)] [G (smooth)] [GH (smooth and printed)] [I (embossed)] [J (embossed-in-register)] [K (surface scored)] [Z (other patterns as described)] [and] [as indicated by manufacturer's designation] <Insert pattern>.
- C. Color: [White] [As selected from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's designation] [As indicated on Drawings] [As indicated in a schedule] <Insert color>.
- D. Light Reflectance (LR): Not less than [LR indicated in a schedule] [0.65] [0.70] [0.75] [0.80] [0.85] [0.90] <Insert LR>.
- E. Ceiling Attenuation Class (CAC): Not less than [CAC indicated in a schedule] [20] [25] [30] [35] [40] <Insert CAC>.
- F. Noise Reduction Coefficient (NRC): Not less than [NRC indicated in a schedule] [0.40] [0.50] [0.55] [0.60] [0.65] [0.70] [0.75] [0.80] [0.85] [0.90] [0.95] [1.00] <Insert NRC>.
- G. Articulation Class (AC): Not less than [AC indicated in a schedule] [170] [180] [190] [200] [210] <Insert AC>.
- H. Edge/Joint Detail: [Square] [Reveal sized to fit flange of exposed suspension-system members] [Flush reveal sized to fit flange of exposed suspension-system members] [Beveled, kerfed, and rabbeted long edges and square, butt-on short edges] [As indicated by manufacturer's designation] <Insert requirement>.
- I. Thickness:
1. [5/8 inch] [3/4 inch] [7/8 inch] [As indicated on Drawings] [As indicated in a schedule] <Insert thickness>.
 2. [1/8 inch] [7/16 inch] [9/16 inch] [5/8 inch] [3/4 inch] [7/8 inch] [1 inch] [1-1/2 inches] [2 inches] [3 inches] [As indicated on Drawings] [As indicated in a schedule] <Insert dimension>.
- J. Modular Size: [24 by 24 inches] [24 by 48 inches] [24 by 72 inches] [24 by 96 inches] [48 by 48 inches] [600 by 600 mm] [600 by 1200 mm] [As indicated on Drawings] [As indicated in a schedule] <Insert size>.
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.
- 2.05 METAL SUSPENSION SYSTEM <Insert drawing designation>
- A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories in accordance with ASTM C635/C635M and designated by type, structural classification, and finish indicated.
1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" in accordance with ASTM C635/C635M.

- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
1. Fire Rating: [As indicated on Drawings] <Insert fire rating>.
 2. Structural Classification: **[Intermediate] [Heavy]**-duty system.
 3. End Condition of Cross Runners: **[Override (stepped)] [or] [butt-edge]** type.
 4. Face Design: Flat, flush.
 5. Cap Material: **[Cold-rolled steel] [or] [aluminum]**.
 6. Cap Finish: **[Painted white] [Painted in color as selected from manufacturer's full range] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Plated with metallic finish as selected from manufacturer's full range] [Plated with metallic finish indicated by manufacturer's designation] [Natural finish for aluminum]**.
- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Structural Classification: **[Intermediate] [Heavy]**-duty system.
 2. End Condition of Cross Runners: **[Override (stepped)] [or] [butt-edge]** type.
 3. Face Design: **[Flat, flush] [Flanges formed with an integral center reveal]**.
 4. Cap Material: **[Cold-rolled steel] [or] [aluminum]**.
 5. Cap Finish: **[Painted white] [Painted in color as selected from manufacturer's full range] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Plated with metallic finish as selected from manufacturer's full range] [Plated with metallic finish indicated by manufacturer's designation] [Natural finish for aluminum]**.
- D. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished, cold-rolled, 9/16-inch- wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. Face Design: Flat, flush.
 3. Cap Finish: **[Painted white] [Painted in color as selected from manufacturer's full range] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Plated with metallic finish as selected from manufacturer's full range] [Plated with metallic finish indicated by manufacturer's designation]**.
- E. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; to produce structural members with 9/16-inch- wide faces.
1. Structural Classification: **[Intermediate] [Heavy]**-duty system.

2. Face Design: [With **1/8-inch-** wide, slotted, box-shaped flange] [With **1/4-inch-** wide, slotted, box-shaped flange] [Flanges formed in stepped design with a center protrusion projecting **19/64 inch** below flange surfaces supporting panel faces and forming **3/16-inch-** wide reveals between edges of protrusion and those of panels].
 3. Face Finish: Painted [white] [in color as selected from manufacturer's full range] [to match color indicated by manufacturer's designation] [to match color of acoustical unit].
 4. Reveal Finish: Painted [to match flange color] [white] [black] [in color other than flange color as selected from manufacturer's full range of contrasting reveal colors].
- F. Wide-Face, Aluminum-Capped, Double-Web, Hot-Dip Galvanized, G60 (Z180), Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized, G60 coating designation; with prefinished, 15/16-inch- wide aluminum caps on flanges.
1. Fire Rating: [As indicated on the Drawings] <Insert fire rating>.
 2. Structural Classification: [Intermediate] [Heavy]-duty system.
 3. Face Design: Flat, flush.
 4. Cap Finish: [Painted white] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Natural finish].
- G. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.
1. Structural Classification: Heavy-duty system.
 2. Face Finish: Painted [white] [black].
- H. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from Type 304 or 316 stainless steel sheet, with prefinished 15/16-inch- wide, stainless steel caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. Face Design: Flat, flush.
- I. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 9/16-inch- wide faces.
1. Structural Classification: [Intermediate] [Heavy]-duty system.
 2. Face Design: Screw-slot profile.
 3. Face Finish: [Painted white] [Satin anodized in accordance with AAMA 611, AA-M12C22A31].
 4. Reveal Finish: [Match face finish] [Painted white] [Painted black].
- J. Extra-Wide-Face, Metal Suspension System: Main and cross runners formed from [extruded aluminum] [aluminum-capped steel] [steel-capped steel] <Insert description> to produce structural members with [1-1/2-inch-] [2-inch-] wide flanges.
1. Structural Classification: [Intermediate] [Heavy]-duty system.
 2. Face Design: Flat, flush.

3. Face Finish: **[Painted white]** **[Satin anodized in accordance with AAMA 611, AA-M12C22A31]**.
4. Gasket System: Clean-room type.

2.06 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **[five]** **<Insert safety factor>** times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: **[Cast-in-place]** **[Post-installed expansion]** **[Post-installed bonded]** anchors.
 - b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
 - c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
 - d. Corrosion Protection, Nickel-Copper Alloy: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **[10]** **<Insert safety factor>** times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
 4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than **[0.106-inch-]** **[0.135-inch-]** **<Insert dimension>** diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- F. Hold-Down Clips: Manufacturer's standard hold-down.

- G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
- H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.
- I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- K. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including **[manufacturer's standard] [closed-cell PVC] [neoprene] [antimicrobial]** gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.07 METAL EDGE MOLDINGS AND TRIM <Insert drawing designation>

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Edge moldings to fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide **[stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member]** <Insert description>.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.08 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.03 INSTALLATION OF ACOUSTICAL PANEL CEILINGS

- A. Install acoustical panel ceilings in accordance with ASTM C636/C636M [**seismic design requirements,**] and manufacturer's written instructions.
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems in accordance with tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required [**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - b. Install panels with pattern running in one direction parallel to **[long]** **[short]** axis of space.
 - c. Install panels in a basket-weave pattern.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.

5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install **[hold-down] [impact] [and] [seismic]** clips in areas indicated; space in accordance with panel manufacturer's written instructions unless otherwise indicated.
 - a. Hold-Down Clips: Space **[24 inches]** <Insert dimension> o.c. on all cross runners.
7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts in accordance with requirements indicated for fire-resistance-rated assembly.

3.04 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of **[1/8 inch in 12 feet]** <Insert dimensions>, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of **[1/8 inch in 12 feet]** <Insert dimensions>, non-cumulative.

3.05 FIELD QUALITY CONTROL

- A. Special Inspections: **[Owner will engage] [Engage]** a qualified special inspector to perform the following special inspections:
 1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.
- B. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
 1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and post-installed anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two post-installed anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

- D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.06 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

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SECTION 09 54 23
LINEAR METAL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Linear metal ceilings.

1.02 ALLOWANCES

- A. See Section 01 21 00 "Allowances" for description of allowances affecting items specified in this Section.

1.03 UNIT PRICES

- A. See Section 01 22 00 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.04 ALTERNATES

- A. See Section 01 23 00 "Alternates" for description of alternates affecting items specified in this Section.

1.05 COORDINATION

- A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.06 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
 - 1. <Insert participant requirements>.

1.07 ACTION SUBMITTALS

- A. Product Data: For linear metal ceilings.
- B. Shop Drawings: For linear metal ceilings.
 - 1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:
 - a. Linear ceiling patterns and joints.
 - b. Ceiling suspension members.

- c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 - e. Ceiling perimeter and penetrations through ceiling; trim and moldings.
- C. Samples: For each exposed product and for each type, color, and finish specified, 12 inches long in size.
- D. Samples for Initial Selection: For units with factory-applied colors and finishes.
- 1. Include Samples of accessories involving color and finish selections.
- E. Samples for Verification: For the following products:
- 1. Linear Metal Pans: 12 inches long by full-width Samples of each type, color, and finish and a 12-inch-long spliced section.
 - 2. Suspension-System Members: 12-inch-long Sample of each type.
 - 3. Exposed Molding and Trim: 12-inch-long Samples of each type, color, and finish.
 - 4. Filler Strips: 12-inch-long Samples of each type, color, and finish.
 - 5. Sound Absorbers: 12 inches long by full width.
 - 6. End Caps: Full size.
- F. Delegated Design Submittals: For design of [**seismic restraints and**] attachment devices.
- 1.08 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For testing agency.
 - B. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.
 - C. Evaluation Reports: For linear-metal-ceiling framing systems.
 - D. Field quality-control reports.
- 1.09 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For finishes to include in maintenance manuals.
- 1.10 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Linear-Metal-Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to **[2]** <Insert number> percent of quantity installed.

1.11 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockup of each type of linear metal ceiling as shown on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle ceiling components and accessories in a manner that prevents damage.

1.13 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements" to design **[seismic restraints and]** attachment devices.
- B. Structural Performance: Exterior linear metal ceilings to withstand exterior exposure, the effects of gravity loads, and the following loads and stresses without showing permanent deformation of ceiling system components, including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:
 - 1. Wind Load: Uniform pressure **[indicated on Drawings]** <Insert requirements>, acting inward or outward.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): **[120 deg F, ambient; 180 deg F material surfaces]** <Insert requirements>.
- D. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions in accordance with **[ASTM E580/E580M]** **[CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2"]** **[CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4"]** **[ASCE/SEI 7]** <Insert requirements> and requirements of authorities having jurisdiction.

2.03 LINEAR METAL CEILINGS <Insert drawing designation>

- A. Pans and Suspension System:
- B. Metal Pans: Complying with ASTM E1264 for **[Type XIII]** **[Type XX]** and formed to snap on to carriers securely, without separate fasteners.
 - 1. Surface-Burning Characteristics: For metal-pan assemblies, including backings, determined by testing in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: **[25]** <Insert value> or less.
 - b. Smoke-Developed Index: **[50]** **[55]** <Insert value> or less.
 - 2. Metal: **[Aluminum sheet, ASTM B209, alloy and temper recommended by producer and finisher for type of use and finish indicated]** **[Electrolytic zinc-coated steel sheet, ASTM A879/A879M, 04Z coating; surface treatment as recommended by finish manufacturer for type of use and painted finish indicated]** <Insert requirements>.
 - 3. Form: **[Perforated]** **[Nonperforated]**.
 - a. Perforation Pattern: **[As indicated by manufacturers designation]** <Insert requirements>.
 - 4. Noise Reduction Coefficient (NRC) Rating: Not less than **[0.70]** **[0.75]** **[0.85]** **[1.00]** <Insert requirements> when tested in accordance with ASTM C423.
 - 5. Backing: **[Manufacturer's standard to provide NRC rating indicated for perforation pattern indicated]** **[Nonwoven black fabric]** **[Nonwoven black fabric with 1-inch-thick glass fiber, 1 lb/cu. ft. density, enclosed in black polyethylene]** **[1-inch-thick glass fiber, 1 lb/cu. ft. density, enclosed in black polyethylene]** <Insert requirements>.
 - 6. Pan Thickness: Not less than **[0.020 inch]** **[0.025 inch]** **[0.028 inch]** **[0.040 inch]** <Insert dimension>.
 - 7. Pan Edge Detail: **[Beveled]** **[Square]** **[Round]** **[Manufacturer's standard]**.
 - 8. Pan Width: **[2-inch module width and 1-1/4-inch face width]** **[4-inch module width and 3-1/4-inch face width]** **[6-inch module width and 5-1/4-inch face width]** **[8-inch module width and 7-1/4-inch face width]** **[As indicated on Drawings]** <Insert dimensions>.

9. Pan Depth: **[5/8 inch] [3/4 inch] [1 inch] [1-1/2 inches]** [As indicated on Drawings] <Insert dimension>.
10. Metal-Pan Finish: Protected on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping and as follows:
 - a. Aluminum Anodic Finish: **[Clear finish, AAMA 611, AMP 500 AA-M12C22A31, Class II, 0.010 mm or thicker] [Clear, mirror finish, AMP 500 AA-M21C12A212, 0.005 mm or thicker]** <Insert requirements>.
 - b. Color-Coated Finish: Manufacturer's standard **[powder-coat]** baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
 - 1) Color and Pattern: **[As selected by Architect from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's product designation]** <Insert requirements>.
 - 2) Light Reflectance (LR) Coefficient: Not less than **[0.61] [0.77] [0.81]** <Insert value> LR when tested in accordance with ASTM E1477.
 - c. Laminated-Film Finish: Provide **[manufacturer's standard] [vinyl] [PVC-free]** <Insert requirements> film permanently bonded to metal pan with adhesive.
 - 1) Color and Pattern: **[As selected by Architect from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's product designation]** <Insert requirements>.
 - d. Wood-Veneer Finish: **[Match Architect's sample] [As indicated by manufacturer's product designation] [Wood veneer in species and finish selected by Architect from manufacturer's full range]** <Insert requirements>; permanently bonded to metal pan with adhesive.
 - e. Finish Bonding Adhesive: Manufacturer's standard that permanently bonds finish to aluminum.
- C. Pan Splices: Formed for snap fit into butt-cut pans, **[4 inches] [8 to 12 inches]** <Insert dimension> long.
 1. Finish: **[Manufacturer's standard] [Matte black] [Matching pan]** <Insert requirements>.
- D. End Caps: Manufacturer's standard material fabricated to fit and conceal exposed ends of pans.
 1. Finish: **[Manufacturer's standard] [Matte black] [Matching pan]** <Insert requirements>.
- E. Filler Strips: Manufacturer's standard, fabricated to close voids between pans.
 1. Type: **[Recessed] [Flush] [Integral extension of pan profile] [Expansion, for use with expansion carriers] [Slotted, for air diffusion]** <Insert requirements>.
 2. Finish: **[Manufacturer's standard] [Matte black] [Matching pan]** <Insert requirements>.

- F. Moldings and Trim: Manufacturer's standard for exposed members, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.
- G. Carrier Suspension System: Manufacturer's standard complying with requirements in ASTM C635/C635M for applications indicated; complete with carriers, splice sections, stabilizing components, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
1. Material: [ASTM A653/A653M, hot-dip galvanized, cold-rolled sheet steel, **G60** coating designation] [ASTM A879/A879M, electrolytic zinc-coated, cold-rolled steel, **08Z** coating designation] [ASTM B209 aluminum] <Insert requirements>.
 2. Structural Classification: [**Heavy-duty**] <Insert requirements> system.
 3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
 4. Flexible Radial Carriers: Manufacturer's standard radial carriers.
 5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
 6. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers.
 7. Carrier Splices: Same metal, profile, and finish as for carriers.
 8. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
 9. Carrier Finish: [Flat black] <Insert requirements>.

2.04 CARRIER-SYSTEM HANGERS, BRACES, AND TIES

- A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **[5]** <Insert safety factor> times that imposed by ceiling construction as determined by testing in accordance with ASTM E488/E488M or ASTM E1512, as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: [Cast-in-place] [Postinstalled expansion] [Postinstalled bonded] anchors.
 - b. Corrosion Protection:

- 1) Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
 - 2) Stainless steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
 - 3) Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.
2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to **[10] <Insert safety factor>** times that imposed by ceiling construction as determined by testing in accordance with ASTM E1190 conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
 4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provides not less than **[0.106-inch-] [0.135-inch-] <Insert dimension>** diameter wire.
- C. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed from 0.04-inch-thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.
- E. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.
- F. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A653/A653M, G60 coating designation; size and profile as required to withstand wind load.

2.05 ACCESSORIES

- A. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors permitting upward or downward opening.
1. Size: **[As indicated on Drawings] [24 inches square] <Insert requirements>**.
- B. Air-Distribution Devices: Where indicated on Drawings, provide independently suspended air-distribution devices that are relocatable and adjustable from below finished ceiling, that do not interrupt ceiling components, and that are fully concealed by and integrated with ceiling system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of linear metal pans.
 - 1. Balance border widths at opposite edges of each ceiling.
 - 2. Avoid using less-than-half-width pans at borders.

3.03 INSTALLATION OF LINEAR METAL CEILINGS

- A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in 3 inches. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts [**power-actuated fasteners,**] or postinstalled mechanical or adhesive anchors that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in 1-1/2 inches. Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
1. Screw attach moldings to substrate at intervals of not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system carriers so they are aligned and securely interlocked with one another.
1. Install stabilizer channels, tees, and bars at regular intervals to stabilize carriers and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated.
 2. Remove and replace dented, bent, or kinked members.
- F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness.
- G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated on Drawings.
 2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
 - a. Install pans with butt joints **[aligned]** **[aligned, every other pan length]** **[staggered a minimum of 12 inches]** **[randomly aligned]** **[aligned as indicated on Drawings]** **<Insert requirements>** using internal pan splices.
 3. Install directionally textured or patterned metal pans in directions indicated.
 4. Where metal pan ends are visible, install end caps unless trim is indicated.

5. Install filler strips where indicated **[on Drawings]** **<Insert requirements>**.
 6. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.
- H. Install hold-down clips where indicated.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: **[Owner will engage]** **[Engage]** a qualified special inspector to perform the following special inspections:
1. Suspended ceiling system.
 2. Hangers, anchors, and fasteners.
 3. **<Insert special inspections>**.
- B. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers, anchors, and fasteners to take place in successive stages, in test areas and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before pans have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Linear metal ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.05 CLEANING

- A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION

SECTION 09 64 33

LAMINATED WOOD FLOORING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Factory-finished laminated wood flooring.
 - 2. Sound control underlayment.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.
- C. Samples: For each exposed product and for each color and texture specified, approximately 12 inches long and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.
- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and finishes available for wood flooring.
 - 1. Include Samples of accessories involving color and finish selection.
- E. Samples for Verification: For each type of wood flooring and accessory, with stain color and finish required, approximately 12 inches long and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

1.03 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wood flooring materials in unopened cartons or bundles.
- B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet-work is complete and dry.

- C. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

1.05 FIELD CONDITIONS

- A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.
 - 1. Environmental Conditioning: Maintain ambient temperature between 65 and 75 deg F and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.
 - 2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.
 - a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
 - b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.
- B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
- C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hartco prefinished hardwood or equal.
- B. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 FACTORY-FINISHED LAMINATED WOOD FLOORING

- A. Engineered multi-ply laminated construction. Each plank to meet or exceed Hardwood Plywood Veneer Association (HPVA) Type II bond test.
 - 1. Species: As selected by Architect.
 - 2. Thickness: .
 - 3. Construction:
 - 4. Face Width:
 - 5. Length: Manufacturer's standard.
 - 6. Edge Style: Micro Edge / Micro Ends.

2.03 SOUND CONTROL UNDERLAYMENT

- A. Sound Control Underlayment: Sound reducing underlayment consisting of impact-absorbing materials. Minimum Impact Insulation Class (IIC) of 50 when tested according to ASTM E492.
 - 1. Material: Recycled rubber.
 - 2. Thickness: 3/16-inch.
 - 3. Manufacturer: Equal to Geniemat RST05 Sound Control Underlayment by Pliteq.
- B. Perimeter Isolation Strip: Equal to GenieMat PMI-PF-12.

2.04 ACCESSORY MATERIALS

- A. Wood Sleepers and Subfloor: As specified in Section 06 10 53 Miscellaneous Wood Carpentry."
- B. Wood Underlayment: As specified in Section 06 10 53 Miscellaneous Wood Carpentry."
- C. Wood Flooring Adhesive: As recommended by flooring fabricator.
- D. Fasteners: As recommended by manufacturer, but not less than that recommended in NWFA's "Installation Guidelines."
- E. Thresholds and Saddles: To match wood flooring. Tapered on each side.
- F. Reducer Strips: To match wood flooring. 2 inches wide, tapered, and in thickness required to match height of flooring.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines."
- B. Wood Sleepers and Subfloor: Install according to requirements in Section 06 1053 Miscellaneous Rough Carpentry."
- C. Wood Underlayment: 06 10 53 Miscellaneous Rough Carpentry."

- D. Provide expansion space at walls and other obstructions and terminations of flooring of not less than 3/4 inch.
- E. Vapor Retarder: Comply with the following for vapor retarder installation:
 - 1. Wood Flooring Nailed to Wood Subfloor: Install flooring over a layer of asphalt-saturated felt.
 - 2. Wood Flooring Nailed to Sleepers over Concrete: Install flooring over a layer of polyethylene sheet with edges overlapped over sleepers and turned up behind baseboards.
 - 3. Wood Flooring Installed Directly on Concrete: Install a layer of polyethylene sheet according to flooring manufacturer's written instructions.
- F. Sound Control Underlayment: Install over vapor retarder according to manufacturer's written instructions.
- G. Engineered-Wood Flooring: Set in adhesive.

3.04 PROTECTION

- A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.
 - 1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Thermoset-rubber base.
 - 2. Thermoplastic-rubber base.
 - 3. Vinyl base.
 - 4. Rubber stair accessories.
 - 5. Vinyl stair accessories.
 - 6. Rubber molding accessories.
 - 7. Vinyl molding accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- E. Product Schedule: For resilient base and accessory products. **[Use same designations indicated on Drawings.]**

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials **[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than **[10 linear feet]** <Insert dimension> for every **[500 linear feet]** <Insert dimension> or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.05 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **[70 deg F]** <Insert temperature> or more than **[95 deg F]** <Insert temperature>, in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **[55 deg F]** <Insert temperature> or more than **[95 deg F]** <Insert temperature>.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products: See current Campus Specification Matrix for Preferred Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. <Insert requirements>.

2.03 THERMOSET-RUBBER BASE <Insert drawing designation>

- A. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style and Location:
 - a. Style A, Straight: **[Provide in areas with carpet]** <Insert requirements>.

- b. Style B, Cove: [Provide in areas with resilient floor coverings] <Insert requirements>.
 - c. Style C, Butt to: [Provide in areas indicated] <Insert requirements>.
 - B. Thickness: 0.125 inch.
 - C. Height: **[6 inches]** [As indicated on Drawings].
 - D. Lengths: [Cut lengths **48 inches** long] [Coils in manufacturer's standard length] [Cut lengths **48 inches** long or coils in manufacturer's standard length].
 - E. Outside Corners: [Job formed] [Preformed] [Job formed or preformed].
 - F. Inside Corners: [Job formed] [Preformed] [Job formed or preformed].
 - G. Colors: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors>.
- 2.04 THERMOPLASTIC-RUBBER BASE <Insert drawing designation>
- A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: [I (solid, homogeneous)] [or] [II (layered)].
 - 2. Style and Location:
 - a. Style A, Straight: [Provide in areas with carpet] <Insert requirements>.
 - b. Style B, Cove: [Provide in areas with resilient floor coverings] <Insert requirements>.
 - c. Style C, Butt to: [Provide in areas indicated] <Insert requirements>.
 - d. Style D, Sculptured: [Provide in areas indicated] <Insert requirements>.
 - 1) Profile: [As indicated] <Insert requirement>.
 - B. Thickness: **[0.125 inch]** <Insert dimension>.
 - C. Height: **[2-1/2 inches]** **[4 inches]** **[6 inches]** [As indicated on Drawings].
 - D. Lengths: [Cut lengths **48 inches** long] [Coils in manufacturer's standard length] [Cut lengths **48 inches** long or coils in manufacturer's standard length].
 - E. Outside Corners: [Job formed] [Preformed] [Job formed or preformed].
 - F. Inside Corners: [Job formed] [Preformed] [Job formed or preformed].
 - G. Colors: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors>.
- 2.05 VINYL BASE <Insert drawing designation>
- A. Product Standard: ASTM F1861, Type TV (vinyl, thermoplastic).
 - 1. Group: [I (solid, homogeneous)] [or] [II (layered)].
 - 2. Style and Location:

- a. Style A, Straight: [Provide in areas with carpet] <Insert requirements>.
 - b. Style B, Cove: [Provide in areas with resilient floor coverings] <Insert requirements>.
- B. Minimum Thickness: [0.125 inch] [0.080 inch] <Insert dimension>.
- C. Height: [2-1/2 inches] [4 inches] [6 inches] [As indicated on Drawings].
- D. Lengths: [Cut lengths 48 inches long] [Coils in manufacturer's standard length] [Cut lengths 48 inches long or coils in manufacturer's standard length].
- E. Outside Corners: [Job formed] [Preformed] [Job formed or preformed].
- F. Inside Corners: [Job formed] [Preformed] [Job formed or preformed].
- G. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors and patterns>.
- 2.06 RUBBER STAIR ACCESSORIES <Insert drawing designation>
- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
- 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Stair Treads: ASTM F2169.
- 1. Type: [TS (rubber, vulcanized thermoset)] [or] [TP (rubber, thermoplastic)].
 - 2. Class: [1 (smooth, flat)] [2 (pattern; embossed, grooved, or ribbed)].
 - 3. Group: [1 (embedded abrasive strips)] [2 (with contrasting color for the visually impaired)].
 - 4. Nosing Style: [Square, adjustable to cover angles between 60 and 90 degrees] [Square] [Round].
 - 5. Nosing Height: [1-1/2 inches] [2 inches] [2-3/16 inches] <Insert dimension>.
 - 6. Thickness: [1/4 inch and tapered to back edge] <Insert thickness>.
 - 7. Size: Lengths and depths to fit each stair tread in [one piece] [one piece or, for treads exceeding maximum lengths manufactured, in equal-length units].
 - 8. Integral Risers: Smooth, flat; in height that fully covers substrate.
 - 9. Provide contrasting stripe at top and bottom steps for visually impaired.
- C. Separate Risers: Smooth, flat; in height that fully covers substrate; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
- 1. Style: [Coved toe, 7 inches high by length matching treads] [Toeless, by length matching treads].
 - 2. Thickness: [0.125 inch] [Manufacturer's standard] <Insert thickness>.
- D. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer as treads, and recommended by manufacturer for installation with treads.
- 1. Thickness: [0.125 inch] [0.080 inch] [Manufacturer's standard] <Insert thickness>.

- E. Landing Tile: [Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads] <Insert requirements>.
- F. Locations: [Provide rubber stair accessories in areas indicated] <Insert requirements>.
- G. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors and patterns>.

2.07 VINYL STAIR ACCESSORIES <Insert drawing designation>

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Stair Treads: ASTM F2169, Type TV (vinyl, thermoplastic).
 - 1. Class: [1 (smooth, flat)] [2 (pattern; embossed, grooved, or ribbed)].
 - 2. Group: [1 (embedded abrasive strips)] [2 (with contrasting color for the visually impaired)].
 - 3. Nosing Style: [Square, adjustable to cover angles between 60 and 90 degrees] [Square] [Round].
 - 4. Nosing Height: [1-1/2 inches] [2 inches] [2-3/16 inches] <Insert dimension>.
 - 5. Thickness: [1/4 inch and tapered to back edge] <Insert thickness>.
 - 6. Size: Lengths and depths to fit each stair tread in [one piece] [one piece or, for treads exceeding maximum lengths manufactured, in equal-length units].
 - 7. Integral Risers: Smooth, flat; in height that fully covers substrate.
 - 8. Provide contrasting stripe at top and bottom steps for visually impaired.
- C. Separate Risers: Smooth, flat; in height that fully covers substrate; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
 - 1. Style: [Coved toe, 7 inches high by length matching treads] [Toeless, by length matching treads].
 - 2. Thickness: [0.125 inch] [0.080 inch] [Manufacturer's standard] <Insert thickness>.
- D. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer as treads, and recommended by manufacturer for installation with treads.
 - 1. Thickness: [0.125 inch] [0.080 inch] [Manufacturer's standard] <Insert thickness>.
- E. Landing Tile: [Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads] <Insert requirements>.
- F. Locations: [Provide vinyl stair accessories in areas indicated] <Insert requirements>.
- G. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors and patterns>.

2.08 RUBBER MOLDING ACCESSORY <Insert drawing designation>

- A. Description: Rubber [stair-tread nosing] [cap for cove carpet] [cap for cove resilient floor covering] [carpet bar for tackless installations] [carpet edge for glue-down applications] [nosing for carpet] [nosing for resilient floor covering] [reducer strip for resilient floor covering] [joiner for tile and carpet] [transition strips] <Insert description>.
- B. Profile and Dimensions: [As indicated] <Insert profile and dimensions>.
- C. Locations: [Provide rubber molding accessories in areas indicated] <Insert requirements>.
- D. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors and patterns>.

2.09 VINYL MOLDING ACCESSORY <Insert drawing designation>

- A. Description: Vinyl [stair-tread nosing] [cap for cove carpet] [cap for cove resilient floor covering] [carpet bar for tackless installations] [carpet edge for glue-down applications] [nosing for carpet] [nosing for resilient floor covering] [reducer strip for resilient floor covering] [joiner for tile and carpet] [transition strips] <Insert description>.
- B. Profile and Dimensions: [As indicated] <Insert profile and dimensions>.
- C. Locations: [Provide vinyl molding accessories in areas indicated] <Insert requirements>.
- D. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] <Insert colors and patterns>.

2.10 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.
- D. Metal Edge Strips: **[Extruded aluminum with mill finish]** <Insert requirements>, nominal 2 inches wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.
- E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than **[9] [10]** **<Insert number>** pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed **[200 sq. ft.] [1000 sq. ft.] <Insert area>**, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[3 lb of water/1000 sq. ft.] <Insert rate>** in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum **[75] <Insert number>** percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than **[3 inches]** <Insert dimension> in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than **[3 inches]** <Insert dimension> in length.
 - a. **[Miter] [Cope] [Miter or cope]** comers to minimize open joints.

3.04 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
 - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.
 - 1. Apply **[one] [two] [three]** <Insert requirement> coat(s).

- E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

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SECTION 09 65 19
RESILIENT TILE FLOORING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Solid vinyl floor tile.
 - 2. Rubber floor tile.
 - 3. Vinyl composition floor tile.
 - 4. Resilient terrazzo floor tile.
 - 5. Static dissipative tile.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: Full-size units of each color, texture, and pattern of floor tile required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **[9 inches]** <Insert dimension> long, of each color required.
- D. Samples for Initial Selection: For each type of floor tile indicated.
- E. Samples for Verification: Full-size units of each color and pattern of floor tile required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **[9 inches]** <Insert dimension> long, of each color required.
- F. Welded-Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of **[6-by-9-inch]** <Insert dimensions> Sample applied to a rigid backing and prepared by Installer for this Project.
- G. Product Schedule: For floor tile. [Use same designations indicated on Drawings.]

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials **[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish one box for every **[50] <Insert number>** boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 100 sq. ft. for each type, color, and pattern [in locations indicated] [in locations directed by Architect] <Insert locations>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.09 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **[70 deg F] <Insert temperature>** or more than **[95 deg F] <Insert temperature>**, in spaces to receive floor tile during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **[55 deg F] <Insert temperature>** or more than **[95 deg F] <Insert temperature>**.

- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products: See current Campus Specification Matrix for Preferred Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.03 SOLID VINYL FLOOR TILE <Insert drawing designation>

- A. Tile Standard: ASTM F1700.
 - 1. Class: [As indicated by product designations] [Class I, Monolithic Vinyl Tile] [Class II, Surface-Decorated Vinyl Tile] [Class III, Printed Film Vinyl Tile].
 - 2. Type: [A, Smooth Surface] [B, Embossed Surface].
- B. Thickness: [**0.080 inch**] [**0.100 inch**] [**0.120 inch**] [**0.125 inch**] <Insert dimension>.
- C. Size: [**12 by 12 inches**] [**18 by 18 inches**] [**24 by 24 inches**] [**36 by 36 inches**] [**3 by 36 inches**] <Insert dimensions>.
- D. Seamless-Installation Method: [Heat welded] [Chemically bonded] <Insert requirements>.
- E. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] <Insert colors and patterns>.

2.04 RUBBER FLOOR TILE <Insert drawing designation>

- A. Tile Standard: ASTM F1344, [Class I-A, Homogeneous Rubber Tile, solid color] [Class I-B, Homogeneous Rubber Tile, through mottled] [Class II-A, Laminated Rubber Tile, solid-color wear layer] [Class II-B, Laminated Rubber Tile, mottled wear layer].
- B. Hardness: [Grade 1, minimum hardness of 85] [Grade 2, minimum hardness of 70] [Manufacturer's standard hardness], measured using Shore, Type A durometer according to ASTM D2240.
- C. Wearing Surface: [Smooth] [Textured] [Molded pattern].
 - 1. Molded-Pattern Figure: [Raised discs] [Raised squares] <Insert pattern>.
- D. Thickness: [**0.125 inch**] <Insert dimension>.
- E. Size: [**12 by 12 inches**] [**24 by 24 inches**] <Insert dimensions>.

- F. Seamless-Installation Method: [Heat welded] [Chemically bonded] <Insert requirements>.
- G. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] <Insert colors and patterns>.

2.05 VINYL COMPOSITION FLOOR TILE <Insert drawing designation>

- A. Tile Standard: ASTM F1066, [Class 1, solid color] [Class 2, through pattern] [Class 3, surface pattern].
- B. Wearing Surface: **[Smooth] [Embossed]**.
- C. Thickness: **[0.125 inch]** <Insert dimension>.
- D. Size: 12 by 12 inches.
- E. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] <Insert colors and patterns>.

2.06 RESILIENT TERRAZZO FLOOR TILE <Insert drawing designation>

- A. Resilient Terrazzo Floor Tile: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective coating.
- B. Thickness: **[1/8 inch] [3/16 inch]**.
- C. Size: **[12 by 12 inches] [24 by 24 inches] [24 by 48 inches]**.
- D. Seamless-Installation Method: Chemically bonded.
- E. Accessories:
 - 1. Base: **[3 inches] [4 inches] [6 inches]** tall.
 - a. Type: [Sanitary, coved] [Straight].
 - 2. Divider strips.
 - 3. <Insert accessory>.
- F. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] <Insert colors and patterns>.

2.07 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.

- a. Colors: [As selected by Architect from manufacturer's full range to contrast with floor tile] [Match floor tile] <Insert colors>.
2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.
- E. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade recommended in writing by floor tile manufacturer to suit resilient terrazzo floor tile.
 1. Joint-Sealant Color: [White] [As selected by Architect from manufacturer's full range to match floor tile] [Match floor tile] <Insert color>.
- F. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Products recommended by floor tile manufacturer for resilient terrazzo floor tile.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than **[9] [10]** <Insert number> pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed **[200 sq. ft.] [1000 sq. ft.]** <Insert area>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[3 lb of water/1000 sq. ft.]** <Insert rate> in 24 hours.

- b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum **[75]** <Insert number> percent relative humidity level measurement.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.03 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles [square with room axis] [at a 45-degree angle with room axis] [in pattern indicated] <Insert requirements>.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles [with grain running in one direction] [with grain direction alternating in adjacent tiles (basket-weave pattern)] [in pattern of colors and sizes indicated].
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.
- J. Resilient Terrazzo Accessories: Install according to manufacturer's written instructions.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
1. Remove adhesive and other blemishes from surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
1. Apply [one] [two] [three] <Insert requirements> coat(s).
- E. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
1. Sealer: Apply two base coats of liquid sealer.
 2. Finish: Apply **[two] [three]** <Insert requirements> coats of liquid floor finish.
- G. Cover floor tile until Substantial Completion.

END OF SECTION

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SECTION 09 66 23

RESINOUS MATRIX TERRAZZO FLOORING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring.
2. Precast epoxy-resin terrazzo units.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealants installed with terrazzo.
2. Section 096723 "Resinous Flooring" for decorative resinous flooring systems applied as self-leveling slurries or as troweled or screeded mortars.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Review special terrazzo designs and patterns.
 - d. <Insert agenda items>.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Accessory strips.
4. Abrasive strips.
5. Stair treads, risers, and landings.

6. Precast terrazzo jointing and edge configurations.
 7. Terrazzo patterns.
 8. <Insert requirements>.
- C. Samples: For each exposed product and for each color and texture specified, **[6 inches]** <Insert dimension> in size.
- D. Samples for Initial Selection: NTMA's "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.
- E. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:
1. Terrazzo: **[6-inch-]** <Insert dimension> square Samples.
 2. Precast Terrazzo: **[6-inch-]** <Insert dimension> square Samples.
 3. Accessories: **[6-inch-]** <Insert dimension> long Samples of each exposed strip item required.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Material Certificates: For each type of terrazzo material or product.
 - C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
 - D. Preinstallation moisture-testing reports.
 - E. Slip Resistance Product Information / Testing.
- 1.06 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For terrazzo to include in maintenance manuals.
- 1.07 QUALITY ASSURANCE
- A. Installer Qualifications:
 1. Engage an installer who is a contractor member of NTMA.
 2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
 - B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 1. Build mockups for terrazzo including accessories.
 - a. Size: Minimum 100 sq. ft. of typical poured-in-place flooring **[and base]** condition for each color and pattern **[in locations indicated] [in locations directed by Architect]** <Insert location requirements>.

- b. Include [base] [first three stair treads] <Insert item>.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- 1.08 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
 - B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- 1.09 FIELD CONDITIONS
 - A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.
 - B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
 - C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
 - D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
 - E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
- PART 2 PRODUCTS
 - 2.01 MANUFACTURERS
 - A. Products: See current Campus Specification Matrix for Preferred Manufacturers.
 - B. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.
 - C. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.
 - 2.02 PERFORMANCE REQUIREMENTS
 - A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.
 - 2.03 EPOXY-RESIN TERRAZZO

- A. Epoxy-Resin Terrazzo **<Insert designation>**: Comply with manufacturer's written instructions for matrix and aggregate proportions and mixing.
- B. Mix Color and Pattern: **[As selected by Architect from manufacturer's full range]** **[As selected by Architect from NTMA's "Terrazzo Color Palette" EI Series]** **[As selected by Architect from NTMA's "Terrazzo Color Palette" EII Series]** **[As selected by Architect from NTMA's "Terrazzo Color Palette" EIII Series]** **[As selected by Architect from NTMA's "Terrazzo Color Palette" EIV Series]** **[Match Architect's sample]** **[Match existing]** **<Insert NTMA designation or custom mix>..**
- C. Materials:
1. Moisture-Vapor-Emission-Control Membrane: Two-component, high-solids, high-density, low-odor, epoxy-based membrane-forming product produced by epoxy terrazzo manufacturer that reduces moisture emission from concrete substrate to not more than 3 lb of water/1000 sq. ft. in 24 hours.
 2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D412.
 - a. Reinforcement: Fiberglass scrim.
 3. Primer: **[Manufacturer's product recommended for substrate and use indicated]** **<Insert requirements>**.
 4. Epoxy-Resin Matrix: **[Manufacturer's standard recommended for use indicated]** **<Insert requirements>** and in color required for mix indicated.
 - a. Physical Properties without Aggregates:
 - 1) Hardness: 60 to 85 per ASTM D2240, Shore D.
 - 2) Minimum Tensile Strength: 3000 psi per ASTM D638 for a 2-inch specimen made using a "C" die per ASTM D412.
 - 3) Minimum Compressive Strength: 10,000 psi per ASTM D695, Specimen B cylinder.
 - 4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D1308.
 - a) Distilled water.
 - b) Mineral water.
 - c) Isopropanol.
 - d) Ethanol.
 - e) 0.025 percent detergent solution.
 - f) 1.0 percent soap solution.
 - g) 5 percent acetic acid.
 - h) 10 percent sodium hydroxide.
 - i) 10 percent hydrochloric acid.
 - j) 30 percent sulfuric acid.

- b. Physical Properties with Aggregates: For terrazzo blended according to manufacturer's recommendations with one part epoxy resin with three parts marble aggregate consisting of 60 percent No. 1 chips and 40 percent No. 0 chips that is ground and grouted to a 1/4-inch nominal thickness, and cured for 7 days at 75 deg F plus or minus 2 deg F and at 50 percent plus or minus 2 percent relative humidity.
 - 1) Flammability: Self-extinguishing, maximum extent of burning 1/4 inch according to ASTM D635.
 - 2) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F according to ASTM C531.
- 5. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.
 - a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.
- 6. Finishing Grout: Resin based.

2.04 PRECAST EPOXY-RESIN TERRAZZO

- A. Precast Terrazzo Base **<Insert designation>**: Minimum 3/8-inch- thick, epoxy terrazzo units cast in maximum lengths possible, but not less than 36 inches. Comply with manufacturer's written instructions for fabricating precast terrazzo base units in sizes and profiles indicated.
 - 1. Type: **[As indicated]** **[Coved with minimum 3/4-inch radius]** **[Straight]** **[Splayed]** **<Insert requirements>**.
 - 2. Top Edge: **[Straight, unfinished]** **[Beveled with polished top surface]** **[Radius edge with polished top surface]** **<Insert requirements>**.
 - 3. Metal Toe Strip: **[Zinc]** **[Brass]**.
 - 4. Outside Corner Units: With finished returned edges at outside corner.
 - 5. Color, Pattern, and Finish: **[As selected by Architect from full range of industry colors]** **[Match Architect's sample]** **[Match adjacent poured-in-place terrazzo flooring]** **<Insert requirements>**.
- B. Precast Terrazzo Units **<Insert designation>**: Minimum **[3/4-inch]** **<Insert dimension>** thick, epoxy terrazzo units. Comply with manufacturer's written instructions for fabricating precast units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 1/8-inch radius.
 - 1. Color, Pattern, and Finish: **[As selected by Architect from full range of industry colors]** **[Match Architect's sample]** **[Match adjacent poured-in-place terrazzo flooring]** **<Insert requirements>**.

2.05 STRIP MATERIALS

- A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.
 - 1. Material: **[As indicated]** **[White-zinc alloy]** **[Brass]** **[Aluminum]** **[Plastic, in color selected from full range of industry colors]** **<Insert requirements>**.

2. Top Width: [As indicated] [1/8 inch] [1/4 inch] <Insert dimension>.
- B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.
1. Bottom-Section Material: [As indicated] [Galvanized steel] [Matching top-section material] <Insert requirements>.
 2. Top-Section Material: [As indicated] [White-zinc alloy] [Brass] [Aluminum] [Plastic, in color selected from full range of industry colors] <Insert requirements>.
 3. Top-Section Width: [As indicated] [1/8 inch] [1/4 inch] [3/8 inch] [1/2 inch] <Insert dimension>.
- C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.
- D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
1. Base-bead strips for exposed top edge of terrazzo base.
 2. Edge-bead strips for exposed edges of terrazzo.
 3. Nosings for terrazzo stair treads and landings.
 4. <Insert requirements>.
- E. Abrasive Strips: [Three-line] [Two-line] [One-line] [Abrasive nosing strip and two-line] <Insert requirements> abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
1. Width: [1/2 inch] <Insert dimension>.
 2. Depth: As required by terrazzo thickness.
 3. Length: [4 inches less than stair width] [As indicated] <Insert dimension>.
 4. Color: [As selected by Architect from full range of industry colors] <Insert requirements>.
- 2.06 MISCELLANEOUS ACCESSORIES
- A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.
- B. Anchoring Devices:
1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
 2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
- C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- E. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

- F. Sealer: [Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer] [Acrylic] [Urethane] [Chemical-resistant epoxy] [Water based] <Insert requirements>.
1. Surface Friction: Not less than 0.6 according to ASTM D2047.
 2. Acid-Base Properties: With pH factor between 7 and 10.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.02 PREPARATION

- A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
- B. Concrete Slabs:
 1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written instructions.
 - c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.
- C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
- D. Preinstallation Moisture Testing:
 1. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests.
 2. Moisture Testing: Perform tests so that each test area does not exceed **[200 sq. ft.] <Insert area>**, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Moisture-Vapor-Emission Test: Maximum moisture-vapor-emission rate of **[3 lb of water/1000 sq. ft.] <Insert rate>** in 24 hours when tested according to ASTM F1869 using anhydrous calcium chloride.
 - b. Relative Humidity Test: Maximum **[75] <Insert number>** percent relative humidity measurement when tested according to ASTM F2170 using in-situ probes.

3. Proceed with terrazzo installation only after concrete substrates pass moisture testing [or after installation of moisture-vapor-emission-control membrane on substrate areas that fail testing].
- E. Moisture-Vapor-Emission-Control Membrane: Install according to manufacturer's written instructions.
1. Install on concrete substrates that incorporate lightweight aggregates.
 2. Install concrete substrates that fail preinstallation moisture testing.
- F. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer's written instructions.
1. Prepare and prefill substrate cracks with membrane material.
 2. Install membrane [at substrate cracks] [to produce full substrate coverage] in areas to receive terrazzo.
 3. Reinforce membrane with fiberglass scrim.
- G. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.
- 3.03 EPOXY-RESIN TERRAZZO INSTALLATION
- A. Comply with NTMA's written recommendations for terrazzo and accessory installation.
- B. Strip Materials:
1. Divider and Control-Joint Strips:
 - a. Locate divider strips [in locations indicated] <Insert requirements>.
 - b. Install control-joint strips [back to back and directly above concrete-slab control joints] [in locations indicated] <Insert requirements>.
 - c. Install control-joint strips with [1/4-inch] <Insert dimension> gap between strips, and install sealant in gap.
 - d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
 2. Accessory Strips: Install [as required to provide a complete installation] [in locations indicated] <Insert requirements>.
 3. Abrasive Strips: Install with surface of abrasive strip positioned [1/16 inch] <Insert dimension> higher than terrazzo surface.
- C. Apply primer to terrazzo substrates according to manufacturer's written instructions.
- D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions.
1. Installed Thickness: [1/4 inch] [3/8 inch] [As indicated on Drawings] <Insert dimension> nominal.

2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
 - a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
 - b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
 - c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with **[80] [120]**-grit stones or with comparable diamond abrasives until grout is removed from surface.
 3. Installation Tolerance: Limit variation in terrazzo surface from level to **[1/4 inch in 10 feet] <Insert dimensions>**; noncumulative.
- E. Install and finish poured-in-place terrazzo stairs at the same time the adjacent terrazzo flooring is installed.
- F. Install and finish poured-in-place terrazzo base at the same time the adjacent terrazzo flooring is installed.
- 3.04 PRECAST TERRAZZO INSTALLATION
- A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.
 - B. Do not install units that are chipped, cracked, discolored, or improperly finished.
 - C. Seal joints between units with **[joint compound matching precast terrazzo matrix] [joint sealant] <Insert requirements>**.
- 3.05 REPAIR
- A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.
- 3.06 CLEANING AND PROTECTION
- A. Cleaning:
 1. Remove grinding dust from installation and adjacent areas.
 2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.
 - B. Sealing:
 1. Seal surfaces according to NTMA's written recommendations.
 2. Apply sealer according to sealer manufacturer's written instructions.
 - C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 09 67 23

RESINOUS URETHANE AND EPOXY MORTAR FLOORING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes surface preparation and field application of polyurethane modified cement concrete floor coatings.
- B. Related Sections include the following:
- C. Division 01 Section "Sustainable Design Requirements."
- D. Division 09 Section "High Performance Coatings" for coatings in exterior steel and interior concrete, CMU and steel walls.

1.02 REFERENCES

- A. ASTM D 16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
- B. ASTM D 4259 – Standard Practice for Abrading Concrete.
- C. ASTM F 1869 - Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- D. International Concrete Repair Institute (ICRI) Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- E. SSPC-SP 13/NACE 6 - Surface Preparation of Concrete.

1.03 DEFINITIONS

- A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.
- B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preapplication Meeting: Convene a preapplication meeting 2 weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Architect, applicator, and manufacturer's representative. Review the following:
 - 1. Environmental requirements.
 - 2. Protection of surfaces not scheduled to be coated.
 - 3. Surface preparation.
 - 4. Application.
 - 5. Repair.

6. Field quality control.
7. Cleaning.
8. Protection of coating systems.
9. One-year inspection.
10. Coordination with other work.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.
- B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
 1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 2. List of material and application for each coat of each sample. Label each sample for location and application.
 3. Submit samples on the following substrates for Architect's review of color and texture:
 - a. Concrete: Provide 8-inches square samples on rigid backing.
- C. Manufacturer's Quality Assurance: Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
 1. Applicator's Quality Assurance: Submit list of a minimum of 5 completed projects of similar size and complexity to this Work. Include for each project:
 - a. Project name and location.
 - b. Name of owner.
 - c. Name of contractor.
 - d. Name of architect.
 - e. Name of coating manufacturer.
 - f. Approximate area of coatings applied.
 - g. Date of completion.
 - h. Warranty: Submit manufacturer's standard warranty.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. Specialize in manufacture of coatings with a minimum of 5 years successful experience.
 2. Able to demonstrate successful performance on comparable projects.
- B. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.
- C. Applicator's Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.
2. Applicator's Personnel: Employ persons trained for application of specified coatings.

1.07 DELIVERY, HANDLING AND STORAGE

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
1. Coating or material name.
 2. Manufacturer.
 3. Color name and number.
 4. Batch or lot number.
 5. Date of manufacture.
 6. Mixing and thinning instructions.
 - a. Storage:
 7. Store materials in a clean dry area and within temperature range in accordance with manufacturer's instructions.
 8. Keep containers sealed until ready for use.
 9. Do not use materials beyond manufacturer's shelf-life limits.
- B. Handling: Protect materials during handling and application to prevent damage or contamination.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Weather:
1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.
 2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
 3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.
- B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with manufacturer's instructions.
- C. Dust and Contaminants:
1. Schedule coating work to avoid excessive dust and airborne contaminants.
 2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

1.09 EXTRA MATERIALS

- A. Furnish extra coating materials from the same production run as materials applied and in quantities described below. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.
1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include products indicated in the coating system descriptions or equal products by manufacturer listed below. Provide products from one of the following:
1. Tnemec Company, Inc. (Tnemec) (Basis-of-Design). Tel # 310-637-2363
 2. Or approved equal.
- B. Requests for substitution shall include manufacturer's literature for each product giving the name, generic type, descriptive information, solids by volume, recommended film thicknesses and a list of five projects where each product has been used and rendered satisfactory service. No request for substitution shall be considered that would decrease film thickness or offer a change in the generic type of flooring specified.

2.02 MVT SYSTEM FOR CONCRETE FLOORS

- A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.
- C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification equal to or less than that required per local Air Quality Management District.
- D. Interior concrete floor system:
1. MVT /Epoxy/ CR Urethane System:
 2. Surface Preparation: Shot Blast or Mech. Abrade (CSP 3-4).
 3. Prime Coat: Series 208 Epoxoprime MVT. DFT 16 to 20 mils.
 4. Intermediate Coat: Series 237 Power-Tread. DFT 8.0 to 10.0 Mils.
 5. Finish Coat: Series 248 Everthane (with color pak). DFT 2.0 to 3.0 Mils.
 6. Accent Colors: Series 248 Everthane (with color pak). DFT 2.0 to 3.0 Mils.
- E. Colors: Refer to Material Finish Schedule on Drawings for colors.

2.03 ACCESSORIES

- A. Coating Application Accessories:
1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.
 2. Products of coating manufacturer.
- B. Concrete Testing Equipment: American Moisture Test, Inc.:
1. ASTM F1869 water vapor emission test kit

2.04 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
1. Owner may engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 EXECUTION

3.01 EXAMINATION

- A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.
1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
 2. Moisture Vapor Emission Rate: When measured using ASTM F1869 test kit at a minimum of one (1) test for each 1,000 square foot of coating:
 - a. Concrete: 15 lbs.
 3. Start of application is construed as Applicator's acceptance of surfaces within that particular area.
- B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.
1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:
 - a. Confirmation of primer's suitability for expected service conditions.
 - b. Confirmation of primer's ability to be top coated with materials specified.
 2. Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.02 PREPARATION

- A. Protection of surfaces not scheduled to be coated:
1. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
 2. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

- B. Surface preparation of concrete floors: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.
 - 1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
 - 2. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
 - 3. Diamond grind near wall base, columns and edges to expose absorbent concrete.
 - 4. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
 - 5. Allow concrete to cure for a minimum of 28 days before coating.
 - 6. Level protrusions and mortar spatter.
- C. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
 - 2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
 - 3. Use only the type of thinners approved by manufacturer and only within recommended limits.

3.03 APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
- C. Keep containers closed when not in use to avoid contamination.
- D. Do not use mixed coatings beyond pot life limits.
- E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- F. Uniformly apply coatings at spreading rate required to achieve specified DFT.
- G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.
- H. Before applying 248 Everthane thoroughly scarify 237 Power -Tread using a power sander and 100 grit sandpaper, No 60 mesh sanding screen or coarse striping pad to eliminate surface tension

3.04 REPAIR

- A. Materials and Surfaces Not Scheduled to Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.
- B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

- C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.06 CLEANING

- A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.07 PROTECTION

- A. Protect surfaces of coating systems from damage during construction.

END OF SECTION

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SECTION 09 68 13

TILE CARPETING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:

- 1. Modular carpet tile.

- B. Related Requirements:

- 1. Section 024119 "Selective Demolition" for removing existing floor coverings.
- 2. [Section 096513 "Resilient Base and Accessories"] [Section 096519 "Resilient Tile Flooring"] for resilient wall base and accessories installed with carpet tile.
- 3. Section 096816 "Sheet Carpeting" for carpet roll goods.

1.03 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at **[Project site] <Insert location>**.

- 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.
 - d. Review layout and orientation.
 - e. <Insert agenda items>.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- 2. Include manufacturer's written installation recommendations for each type of substrate.

- B. Shop Drawings: For carpet tile installation, plans showing the following:

- 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.

2. Carpet tile type, color, and dye lot.
 3. Type of subfloor.
 4. Type of installation.
 5. Pattern of installation.
 6. Pattern type, location, and direction.
 7. Pile direction.
 8. Type, color, and location of insets and borders.
 9. Type, color, and location of edge, transition, and other accessory strips.
 10. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- D. Samples for Initial Selection: For each type of carpet tile.
1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.
- E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- G. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
 - C. Sample Warranty: For special warranty.
- 1.06 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to **[5] <Insert number>** percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the **[Commercial II] [Master II] <Insert description>** certification level.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups at locations and in sizes shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.

- c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 - g. <Insert failure characteristic>.
3. Warranty Period: Lifetime limited from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

1. See current Campus Standards for acceptable Tile Carpeting Manufacturers.

2.02 CARPET TILE <Insert drawing designation>

- A. Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>.
- B. Pattern: [Match Architect's samples] <Insert pattern>.
- C. Fiber Content: [100 percent nylon 6, 6] [100 percent nylon 6] [100 percent polypropylene] [100 percent wool] [80 percent wool; 20 percent nylon 6, 6] [80 percent wool; 20 percent nylon 6] <Insert percentage>.
- D. Fiber Type: <Insert proprietary fiber type>.
- E. Pile Characteristic: [Level-loop] [Cut] [Cut-and-loop] <Insert construction> pile.
- F. Yarn Twist: <Insert TPI>.
- G. Yarn Count: <Insert count>.
- H. Density: <Insert oz./cu. yd. >.
- I. Pile Thickness: <Insert inches> for finished carpet tile [according to ASTM D6859].
- J. Stitches: <Insert stitches per inch>.
- K. Gage: <Insert ends per inch>.
- L. Surface Pile Weight: <Insert oz./sq. yd. >.
- M. Total Weight: <Insert oz./sq. yd. > for finished carpet tile.
- N. Primary Backing/Backcoating: [Manufacturer's standard composite materials] [PVC] [Fiberglass-reinforced PVC] [Fiberglass-reinforced amorphous resin] [Reinforced polyurethane composite cushion] [Reinforced polyurethane composite] [Reinforced thermoplastic copolymer] <Insert specific primary backing materials; consult manufacturers>.

- O. Secondary Backing: **[Manufacturer's standard material]** <Insert specific secondary backing material>.
- P. Backing System: <Insert proprietary name>.
- Q. Size: **[18 by 18 inches]** **[24 by 24 inches]** **[18 by 36 inches]** **[36 by 36 inches]** <Insert dimensions>.
- R. Applied Treatments:
1. Soil-Resistance Treatment: **[Manufacturer's standard treatment]** <Insert treatment>.
 2. Antimicrobial Treatment: **[Manufacturer's standard treatment]** <Insert treatment> that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- S. Sustainable Design Requirements:
1. Sustainable Product Certification: **[Silver]** **[Gold]** **[Platinum]** level certification according to ANSI/NSF 140.
- T. Performance Characteristics:
1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm]** **[0.22 W/sq. cm]** according to NFPA 253.
 3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
 4. Tuft Bind: Not less than **[3 lbf]** **[5 lbf]** **[6.2 lbf]** **[8 lbf]** **[10 lbf]** <Insert value> according to ASTM D1335.
 5. Delamination: Not less than **[3.5 lbf/in.]** **[4 lbf/in.]** <Insert value> according to ASTM D3936.
 6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
 8. Noise Reduction Coefficient (NRC): <Insert NRC> according to ASTM C423.
 9. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 10. Colorfastness to Light: Not less than 4 after **[40]** **[60]** <Insert number> AFU (AATCC fading units) according to AATCC 16, Option E.
 11. Electrostatic Propensity: Less than **[3.5]** **[2]** <Insert number> kV according to AATCC 134.

2.03 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
- C. Metal Edge/Transition Strips: Extruded aluminum with **[mill]** **<Insert finish>** finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed **[200 sq. ft.] [1000 sq. ft.] <Insert area>**, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[3 lb of water/1000 sq. ft.] <Insert emission>** in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum **[75] <Insert number>** percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Wood Subfloors: Verify the following:
 - 1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
 - 2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. Metal Subfloors: Verify the following:
 - 1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- F. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer.
 - 1. Access Flooring Systems: Verify the following:

2. Access floor substrate is compatible with carpet tile and adhesive if any.
 3. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than **[1/8 inch <Insert dimension>**, protrusions more than 1/32 inch, and substances that may interfere with adhesive bond or show through surface.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.03 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: **[As recommended in writing by carpet tile manufacturer] [Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive] [Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive] [Free lay; install carpet tiles without adhesive].**
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns **[indicated on Drawings] [recommended in writing by carpet tile manufacturer].**
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.04 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 09 69 00
ACCESS FLOORING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Cementitious-core steel panel access flooring.
 2. Wood-core steel panel access flooring.
 3. Unfilled steel panel access flooring.
 4. Aluminum panel access flooring.

1.02 ALLOWANCES

- A. Allowances for access flooring are specified in Section 01 21 00 "Allowances."
1. Cutouts in floor panels are part of **<Insert name of allowance>**.
 2. Service outlets are part of **<Insert name of allowance>**.

1.03 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 01 22 00 "Unit Prices."
1. Unit prices apply to authorized work covered by **[quantity allowances] [estimated quantities]**.
 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
1. Review connections between access flooring and mechanical and electrical systems.
 2. Review requirements related to sealing the plenum.
 3. Review procedures for keeping underfloor space clean.

1.05 ACTION SUBMITTALS

- A. Product Data:
1. Cementitious-core steel panel access flooring.
 2. Wood-core steel panel access flooring.
 3. Unfilled steel panel access flooring.
 4. Aluminum panel access flooring.
- B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for access flooring.
 2. Include loading capacities.
- C. Shop Drawings: For access flooring:
1. Include layout of access flooring and relationship to adjoining Work based on field-verified dimensions.
 2. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.
- D. Samples: For the following products:
1. Floor Coverings: Full-size units for each color and texture specified.
 2. Exposed Metal Accessories: Approximately 10 inches in length.
 3. One full-size floor panel, pedestal, and understructure unit for each type of access flooring required.
- E. Samples for Initial Selection: For each type of exposed finish.
- F. Samples for Verification: For the following products:
1. Floor Coverings: Full-size units.
 2. Exposed Metal Accessories: Approximately 10 inches in length.
 3. One full-size floor panel, pedestal, and understructure unit for each type of access flooring required.
- G. Delegated Design Submittals: For seismic design of access flooring.
- 1.06 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings:
1. Coordinate mechanical and electrical work in underfloor cavity to prevent interference with access flooring.
 2. Mark pedestal locations on subfloor to enable mechanical and electrical work to proceed without interfering with access-flooring pedestals installed after mechanical and electrical work.
- B. Qualification Data: For **[Installer] [and] [testing agency]**.
- C. Product Certificates: For each type of access flooring.
- D. Product Test Reports: For each type of access-flooring material and floor covering, performed by a qualified testing agency.
- E. Seismic Design Calculations: For seismic design of access flooring, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Preconstruction Test Reports: For preconstruction adhesive field test.
- 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panels: <Insert number>.
 - 2. Gratings: <Insert number>.
 - 3. Pedestals: <Insert number>.
 - 4. Stringers: <Insert number>.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical access flooring, as shown on Drawings. Size to be an area no fewer than **[five]** <Insert number> floor panels in length by **[five]** <Insert number> floor panels in width.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: **[Owner will engage]** **[Engage]** a qualified testing agency to perform preconstruction testing on field mockups.
 - 1. <Insert sizes and configurations of assemblies>.
 - 2. Use personnel, materials, and methods of construction that will be used at Project site.
 - 3. Notify Architect **[seven]** <Insert number> days in advance of the dates and times when laboratory mockups will be tested.
- B. Preconstruction Adhesive Field Test: Before installing pedestals, field test their adhesion to subfloor surfaces by doing the following:
 - 1. In areas representative of each subfloor surface, set typical pedestal assemblies in same adhesive, and use methods required for the completed Work.
 - 2. Allow test installation to cure for manufacturer's recommended cure time, with a pressure of 25 lbf applied vertically to pedestals during this period.
 - 3. After curing, apply lateral load against a straight steel bar inserted 2 inches into pedestal stems. Measure the force needed to cause adhesive failure of pedestal base.
 - 4. Remove and discard failed pedestals, and clean pedestals of adhered residue.
 - 5. Proceed with installation only after tests show compliance with performance requirement specified for pedestals' capability to resist overturning moment.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install access flooring until spaces are enclosed, [**subfloor has been sealed,**] ambient temperature is between 50 and 90 deg F, and relative humidity is not less than 20 and not more than 70 percent.

PART 2 PRODUCTS

2.01 MANUFACTURERS

1. See current Campus Standards for acceptable Access Flooring Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design access flooring for seismic performance, including loads imposed on the access flooring by items and equipment installed on the access flooring.
- B. Seismic Performance: Access flooring to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <Insert requirement> [, **including loads imposed on the access flooring by items and equipment installed on the access flooring**].
- C. Structural Performance: Provide access flooring capable of complying with the following performance requirements according to testing procedures in CISCA's "Recommended Test Procedures for Access Floors":
1. Concentrated Loads: [**900 lbf**] [**1000 lbf**] [**1250 lbf**] [**1500 lbf**] [**2000 lbf**] <Insert value> with the following deflection and permanent set:
 - a. Top-Surface Deflection: [**0.10 inch**] <Insert dimension>.
 - b. Permanent Set: [**0.010 inch**] <Insert dimension>.
 2. Ultimate Loads: [**1800 lbf**] [**2000 lbf**] [**2500 lbf**] [**3000 lbf**] [**4000 lbf**] <Insert value>.
 3. Rolling Loads: With local or overall deformation not to exceed 0.040 inch.
 - a. CISCA Wheel 1: 10 passes at [**400 lbf**] [**500 lbf**] [**600 lbf**] [**800 lbf**] [**1000 lbf**] [**1200 lbf**] [**1250 lbf**] [**2000 lbf**] <Insert value>.
 - b. CISCA Wheel 2: 10,000 passes at [**400 lbf**] [**500 lbf**] [**600 lbf**] [**800 lbf**] [**1000 lbf**] [**1250 lbf**] [**1750 lbf**] [**2000 lbf**] <Insert value>.
 4. Stringer Load Test: [**75 lbf**] [**225 lbf**] [**350 lbf**] [**450 lbf**] <Insert value> at center of span with a permanent set not to exceed 0.010 inch.
 5. Pedestal Axial Load Test: [**5000 lbf**] [**6000 lbf**] <Insert value>.
 6. Pedestal-Overturning-Moment Test: [**1000 lbf x inches**] <Insert values>.
 7. Uniform Load Test: [**200 lbf/sq. ft.**] [**250 lbf/sq. ft.**] [**300 lbf/sq. ft.**] [**400 lbf/sq. ft.**] [**500 lbf/sq. ft.**] <Insert value> with a maximum top-surface deflection not to exceed 0.040 inch and a permanent set not to exceed 0.010 inch.
 8. Drop Impact Load Test: [**75 lb**] [**100 lb**] [**125 lb**] [**150 lb**] [**175 lb**] <Insert value>.
- D. Fire Performance:
1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: [**25**] <Insert value> or less.

- b. Smoke-Developed Index: **[50] [450] <Insert value>** or less.

2.03 CEMENTITIOUS-CORE STEEL PANEL ACCESS FLOORING

- A. Cementitious-Core Steel Panel Access Flooring **<Insert drawing designation>**: Fabricate panels from cold-rolled steel sheet, with die-cut flat top sheet and die-formed and stiffened bottom pan welded together. Protect metal surfaces against corrosion using manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.
1. Configuration: Provide modular panels with nominal size of **[24 by 24 inches] <Insert dimensions>**, interchangeable with other field panels without disturbing adjacent panels or understructure.
 2. Tile Carpeting System: Fabricate panels with alignment pins to accept field-installed carpet tile with receptors designed to engage pins.
 3. Attachment to Understructure: **[Bolted] [By gravity]**.
- B. Perforated Panels: Perforated top surface with **[holes] [slots]** of number, spacing, and size standard with manufacturer to produce a nominal open area of **[23] [24] [25] <Insert number>** percent. **[Provide mechanical dampers with each panel unit.]**
1. Quantity: **[As shown on Drawings] <Insert number>**.
 2. Finish: **[Manufacturer's standard] [To match solid panels] <Insert finish>**.
- C. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of **[45] [50] [56] <Insert number>** percent. **[Provide mechanical dampers with each panel unit.]**
1. Quantity: **[As shown on Drawings] <Insert number>**.
 2. Finish: **[Manufacturer's standard] [To match solid panels] <Insert finish>**.
- D. Pedestal System Understructure: System consisting of base, column with provisions for height adjustment, and head (cap); made of steel.
1. Base: Square or circular base with not less than **[16 sq. in.] <Insert dimension>** of bearing area.
 2. Column: Of height required to bring finished floor to elevations indicated. Weld column to base plate.
 3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than **[2 inches] <Insert dimension>** and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
 4. Head: Designed to support the floor panel indicated.
 - a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
 - b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.
- E. Stringer System Understructure: Modular steel stringer systems designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.

1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.
- F. Floor Finish: Provide factory-applied floor finish fabricated in one piece to cover entire panel face; with **[integral trim]** **[applied perimeter plastic]** edging.
1. High-Pressure Plastic Laminate: ISO 4586-5, Abrasion **[Class AC3]** **[Class AC4]** **[Class AC5]**.
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 20,000 megohms when installed floor coverings are surface-to-ground tested according to NFPA 99.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
 2. Static-Dissipative Vinyl Tile: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 1000 megohms when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
 3. Conductive Vinyl Tile: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 25,000 ohms and no more than 1 megohm when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
- 2.04 WOOD-CORE STEEL PANEL ACCESS FLOORING
- A. Wood-Core Steel Panel Access Flooring <Insert drawing designation>: Fabricate panels with 1-inch-thick particleboard core laminated to top and bottom steel face sheets, and with a flame-spread index of 25 or less according to ASTM E84. Provide core edges enclosed with upturned, die-formed, bottom-sheet edge or with perimeter steel channel welded to top sheet and welded or bonded to bottom sheet. Protect metal surfaces against corrosion by manufacturer's standard factory-applied finish.
1. Configuration: Provide modular panels with nominal size of **[24 by 24 inches]** <Insert dimensions>, interchangeable with other field panels without disturbing adjacent panels or understructure.
 2. Tile Carpeting System: Fabricate panels with alignment pins to accept field-installed carpet tile with receptors designed to engage pins.
 3. Attachment to Understructure: **[Bolted]** **[By gravity]**.
- B. Perforated Panels: Perforated top surface with **[holes]** **[slots]** of number, spacing, and size standard with manufacturer to produce a nominal open area of **[23]** **[24]** **[25]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**

1. Quantity: [As shown on Drawings] <Insert number>.
 2. Finish: [Manufacturer's standard] [To match solid panels] <Insert finish>.
- C. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of **[45] [50] [56]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**
1. Quantity: [As shown on Drawings] <Insert number>.
 2. Finish: [Manufacturer's standard] [To match solid panels] <Insert finish>.
- D. Pedestal System Understructure: System consisting of base, column with provisions for height adjustment, and head (cap); made of steel.
1. Base: Square or circular base with not less than **[16 sq. in.]** <Insert dimension> of bearing area.
 2. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
 3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than **[2 inches]** <Insert dimension> and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
 4. Head: Designed to support the floor panel indicated.
 - a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
 - b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.
- E. Stringer System Understructure: Modular steel stringer systems designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.
1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.
- F. Floor Finish: Provide factory-applied floor finish fabricated in one piece to cover entire panel face; with **[integral trim] [applied perimeter plastic]** edging.
1. High-Pressure Plastic Laminate for Wood-Core Steel Panel Access Flooring: ISO 4586-5, Abrasion **[Class AC3] [Class AC4] [Class AC5]**.
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 20,000 megohms when installed floor coverings are surface-to-ground tested according to NFPA 99.
 - b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] **[Match Architect's samples] [As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
 2. Static-Dissipative Vinyl Tile for Wood-Core Steel Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 1000 megohms when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.

- b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert colors, textures, and patterns>.
- 3. Conductive Vinyl Tile for Wood-Core Steel Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 25,000 ohms and no more than 1 megohm when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert colors, textures, and patterns>.

2.05 UNFILLED STEEL PANEL ACCESS FLOORING

- A. Unfilled Steel Panel Access Flooring <Insert drawing designation>: Fabricate panels from cold-rolled steel sheet, with die-cut flat top sheet and die-formed and stiffened bottom pan welded together. Protect metal surfaces against corrosion by manufacturer's standard factory-applied finish.
 - 1. Configuration: Provide modular panels with nominal size of **[24 by 24 inches]** <Insert dimensions>, interchangeable with other field panels without disturbing adjacent panels or understructure.
 - 2. Tile Carpeting System: Fabricate panels with alignment pins to accept field-installed carpet tile with receptors designed to engage pins.
 - 3. Attachment to Understructure: **[Bolted]** **[By gravity]**.
- B. Perforated Panels: Perforated top surface with **[holes]** **[slots]** of number, spacing, and size standard with manufacturer to produce a nominal open area of **[23]** **[24]** **[25]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**
 - 1. Quantity: [As shown on Drawings] <Insert number>.
 - 2. Finish: [Manufacturer's standard] [To match solid panels] <Insert finish>.
- C. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of **[45]** **[50]** **[56]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**
 - 1. Quantity: [As shown on Drawings] <Insert number>.
 - 2. Finish: [Manufacturer's standard] [To match solid panels] <Insert finish>.
- D. Pedestal System Understructure: System consisting of base, column with provisions for height adjustment, and head (cap); made of steel.
 - 1. Base: Square or circular base with not less than **[16 sq. in.]** <Insert dimension> of bearing area.
 - 2. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
 - 3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than **[2 inches]** <Insert dimension> and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.

4. Head: Designed to support the floor panel indicated.
 - a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
 - b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.
 - E. Stringer System Understructure: Modular steel stringer systems designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.
 1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.
 - F. Floor Finish: Provide factory-applied floor finish fabricated in one piece to cover entire panel face; with **[integral trim]** **[applied perimeter plastic]** edging.
 1. High-Pressure Plastic Laminate for Unfilled Steel Panel Access Flooring: ISO 4586-5, Abrasion **[Class AC3]** **[Class AC4]** **[Class AC5]**.
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 20,000 megohms when installed floor coverings are surface-to-ground tested according to NFPA 99.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
 2. Static-Dissipative Vinyl Tile for Unfilled Steel Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 1000 megohms when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
 3. Conductive Vinyl Tile for Unfilled Steel Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 25,000 ohms and no more than 1 megohm when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]** <Insert colors, textures, and patterns>.
- 2.06 ALUMINUM PANEL ACCESS FLOORING
- A. Aluminum Panel Access Flooring <**Insert drawing designation**>: Fabricate panels from manufacturer's standard aluminum alloy with equivalent strength and corrosion resistance to Alloy UNS No. A03830 or UNS No. A03840 according to ASTM B85/B85M. Provide flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.

1. Configuration: Provide modular panels with nominal size of **[24 by 24 inches]** <Insert dimensions>, interchangeable with other field panels without disturbing adjacent panels or understructure.
 2. Attachment to Understructure: **[Bolted]** **[By gravity]**.
 3. Epoxy Finish: **[Conductive]** epoxy powder coating with a minimum average thickness of 2.5 mils and in color selected from manufacturer's full range.
 4. Plated Finish: Nickel-chrome electrodeposited plating, 0.000005-inch chrome over 0.0008-inch nickel, without copper or brass strike, to produce complete coverage over significant surfaces with a matte metallic appearance.
- B. Perforated Panels: Perforated top surface with **[holes]** **[slots]** of number, spacing, and size standard with manufacturer to produce a nominal open area of **[16.5]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**
1. Quantity: **[As shown on Drawings]** <Insert number>.
 2. Finish: **[Manufacturer's standard]** **[To match solid panels]** <Insert finish>.
- C. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of **[55]** <Insert number> percent. **[Provide mechanical dampers with each panel unit.]**
1. Quantity: **[As shown on Drawings]** <Insert number>.
 2. Finish: **[Manufacturer's standard]** **[To match solid panels]** <Insert finish>.
- D. Pedestal System Understructure: System consisting of base, column with provisions for height adjustment, and head (cap); made of aluminum.
1. Base: Square or circular base with not less than **[16 sq. in.]** <Insert dimension> of bearing area.
 2. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
 3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than **[2 inches]** <Insert dimension> and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
 4. Head: Designed to support the floor panel indicated.
 - a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
 - b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.
- E. Stringer System Understructure: Modular aluminum stringer systems designed to bolt to pedestal heads and form a grid pattern.
1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.
- F. Floor Finish: Provide factory-applied floor finish fabricated in one piece to cover entire panel face; with **[integral trim]** **[applied perimeter plastic]** edging.
1. High-Pressure Plastic Laminate for Aluminum Panel Access Flooring: ISO 4586-5, Abrasion **[Class AC3]** **[Class AC4]** **[Class AC5]**.

- a. Electrical Resistance: Average no less than 1 megohm and no more than 20,000 megohms when installed floor coverings are surface-to-ground tested according to NFPA 99.
 - b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert colors, textures, and patterns>.
2. Static-Dissipative Vinyl Tile for Aluminum Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 1000 megohms when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert colors, textures, and patterns>.
 3. Conductive Vinyl Tile for Aluminum Panel Access Flooring: ASTM F1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface).
 - a. Electrical Resistance: Average no less than 25,000 ohms and no more than 1 megohm when installed floor coverings are surface-to-ground tested according to ASTM F150 with 100-V applied voltage.
 - b. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert colors, textures, and patterns>.

2.07 FABRICATION

A. Fabrication Tolerances:

1. Size: Plus or minus 0.020 inch of required size.
2. Squareness: Plus or minus 0.015 inch between diagonal measurements across top of panel.
3. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.

B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.

C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.

1. Captive Fasteners: Provide fasteners held captive to panels.

D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.

1. Number, Size, Shape, and Location: [As indicated.] [As specified in Section 01 21 00 "Allowances" and Section 01 22 00 "Unit Prices."]
2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange. **[Furnish removable covers for grommets.]**
3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.

2.08 ACCESSORIES

- A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
- B. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide **[two] [four]** post-installed **[expansion anchors] [threaded concrete screws]** made from carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5 (5 microns) for Class SC 1 (Mild), with the capability to sustain, without failure, a load equal to **[1.5] <Insert number>** times the loads imposed by pedestal-overturning moment on fasteners, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- C. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:
1. Structural Performance: Cover capable of supporting a **[300-lbf] [800-lbf] [1000-lbf]** concentrated load.
 2. Cover and Box Type: **[Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles] [Grommet with twist-close cover and including steel junction box for electrical receptacle with provision for telephone connectors and signal cables] <Insert type>**.
 3. Location: In center of panel quadrant unless otherwise indicated.
 4. Receptacles and Wiring:
 - a. Electrical receptacles and wiring for service outlets are specified elsewhere.
 - b. Equip each service outlet with power receptacles to comply with the following requirements:
 - 1) Type of Receptacle: Heavy-duty duplex, two-pole, three-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R unless otherwise indicated.
 - 2) Number of Receptacles for Outlet: **[One] [Two] [Four] <Insert number>**.
 - 3) Factory Wired: For field hardwiring with armored cable, containing three insulated No. 12 AWG solid-copper conductors, terminated with a **[6-inch-] <Insert dimension>** long pigtail.
 - 4) Power-in Connectors: Built into outlet housing, of type to fit power-in and power-out connectors of branch-circuit cables supplied with building electrical system.
- D. Occupant Adjustable Diffusers: Manufacturer's standard round diffusers, **[4 inches] [8 inches] <Insert dimension>** in diameter, formed from **[aluminum] [polycarbonate plastic]** to produce a removable one-piece unit complete with diffuser, manually adjustable flow regulator, dirt and dust receptacle, trim ring, and underfloor compression mounting ring; precisely fitted in factory-prepared openings of standard field panels and complying with the following requirements:
1. Air-Distribution Characteristics: **[100 cfm] <Insert value>** at **[0.096-inch] <Insert value>** static pressure and a maximum noise criterion rating of **[15] <Insert number>**.
 2. Structural Performance: Capable of supporting a **[600-lbf] <Insert value>** concentrated load.
 3. Fire-Test-Response Characteristics: Classified 94V-0 according to UL 94.

- E. Floor Grilles: Standard load-bearing grilles formed from **[aluminum] [polycarbonate plastic]** to produce removable one-piece unit precisely fitted in factory-prepared openings of standard field panels, **[with adjustable/removable] [without]** dampers and complying with the following requirements:
1. Air-Distribution Characteristics: 468 cfm at 0.10-inch wg static pressure.
 2. Structural Performance: Capable of supporting a 1000-lbf concentrated load.
 3. Fire-Test-Response Characteristics: Classified 94V-0 according to UL 94.
- F. Plenum-Wall Brush Grommets: Self-sealing cable brush grommet with **[4-by-13-inch rectangular] [3-inch round] [5-inch round]** <Insert dimension(s)> usable area for passage of power and signal cables through plenum walls. Provide **[ABS plastic] [Aluminum]** frame with passageway of interwoven nylon filaments and intermediate layer of EPDM. **[Provide units with plastic cable tray for support of cables and protection of wallboard.]**
- G. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.
- H. Fascia Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal closure plates with **[manufacturer's standard finish]** <Insert finish>.
- I. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, with raised-disc or textured rubber or vinyl-tile floor coverings, and of same materials, performance, and construction requirements as access flooring.
- J. Steps: Provide steps of size and arrangement indicated with floor coverings to match access flooring. Apply nonslip aluminum nosings to treads unless otherwise indicated.
- K. Railings: Standard extruded-aluminum railings at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.
1. Provide railings that comply with structural performance requirements specified in **[Section 05 52 13 "Pipe and Tube Railings."]** **[Section 05 73 00 "Decorative Metal Railings."]**
- L. Panel Lifting Device: Panel manufacturer's standard portable lifting device for each type of panel required **[for each computer room].**
- M. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's authorized representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of conditions and deleterious substances that might interfere with attachment of pedestals.
2. Verify that concrete floor sealer and finish have been applied and cured.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.
- B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.03 INSTALLATION

- A. Install access flooring and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Adhesive Attachment of Pedestals: Set pedestals in adhesive, according to access-flooring manufacturer's written instructions, to provide full bearing of pedestal base on subfloor **[; and as required to meet seismic design requirements]**.
- C. Mechanical Attachment of Pedestals: Attach pedestals to subfloor with post-installed mechanical anchors **[as required to meet seismic design requirements]**.
- D. Adjust pedestals so installed panels are flat, level, and at the proper height.
- E. Stringer Systems: Secure stringers to pedestal heads according to access-flooring manufacturer's written instructions.
- F. Install flooring panels securely in place, leaving them properly seated with panel edges flush. Do not force panels into place.
- G. Scribe perimeter panels to provide a close fit, with adjoining construction having no voids greater than 1/8 inch where panels abut vertical surfaces.
 1. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.
- H. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under installed access flooring.
- I. Grounded Access Flooring: Ground access flooring as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
 1. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.
- J. Underfloor Dividers: Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.
- K. Closures: Scribe closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.

- L. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.
- M. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage, according to manufacturer's written instructions.
- N. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
 - 1. Plus or minus **[1/16 inch] [1/8 inch] <Insert dimension>** in any 10-foot distance.
 - 2. Plus or minus **[1/8 inch] [1/4 inch] <Insert dimension>** from a level plane over entire access flooring area.

3.04 PROTECTION

- A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for **[72] <Insert number>** hours after installation, to allow pedestal adhesive to set.
- B. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

END OF SECTION

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SECTION 09 81 00

ACOUSTIC INSULATION AND SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: The requirements below apply to all rooms and spaces where partitions are indicated to be filled with acoustical insulation and where acoustical insulation is indicated over suspended ceilings. Section includes.
 - 1. Acoustic insulation.
 - 2. Acoustic sealants and related materials.
 - 3. Acoustic pads, tape and gaskets.
- B. Related requirements: Division 07, 22 and 23 for thermal insulation, including pipe and duct insulation.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling and sequencing:
- B. Pre-installation meeting:

1.03 SUBMITTALS

- A. Manufacturer Product Data for materials specified below.

1.04 QUALITY ASSURANCE

- A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.
- B. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
- C. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
- D. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
 - 1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
 - 2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.

1.05 HANDLING

- A. Store materials under cover, protected from moisture and off the ground or floor.
- B. Remove insulation that becomes wet or damp immediately from the job site.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Acoustic sealant and pads shall prevent transmission of airborne sound through cracks in the construction.

2.02 MANUFACTURERS / PRODUCTS

A. Batt insulation:

1. Low-density glass fiber insulation: Use for packing and filling small joints and openings behind sealants.
2. Long-strand glass fiber insulation of one to 2 pcf density, without covering, thickness as required.
 - a. 700 Series Insulation by Owens-Corning Fiberglas.
 - b. Microlite by Johns Manville.
 - c. Toughgard Fiber Glass Duct Liner Insulation by CertainTeed.

B. High-density ceramic or mineral fiber safig:

1. For packing and filling large and/or critical openings, usually behind a sealant or putty.
2. Long-strand ceramic or mineral fiber insulation of minimum 6 pcf density, without covering, thickness as required. Mineral (glass and rock wool) fiber, flame spread and smoke developed in conformance with IBC requirements and other authorities having jurisdiction. Non combustible having a minimum density of 1.1 pcf and minimum Noise Reduction Coefficient of 1.10 at 1/3 Octave Center Frequency (Hz).
 - a. "QuietZone Accoustical Batts" by Owens Corning.
 - b. "Rockwool AFB - Acoustical Fire Batts" by Rockwooll Group.
 - c. "Fibrex Sound Attenuation Batt (SAFB) Insulation" by Fibrex Insulations Inc.
 - d. "Thermafiber" by Owens Corning.
3. Thickness; 2-1/2 inches, except as otherwise indicated.

C. Insulation in stud cavity:

1. Formaldehyde-free, unfaced fiber glass blankets, "Sound-Shield" by Johns Manville, "Greenguard" by Knauf, or equal complying with ASTM C 665, Type 1, unfaced.

Unless other indicated, provide insulation of same thickness as the stud depth. Select batt widths to match stud spacing and to be self supporting between the studs.

- D. For application above ceilings, select batt widths to be supported on ceiling construction over the entire ceiling area.

2.03 BOARD INSULATION

- A. Akousti-Liner R by Manson, or equal complying with ASTM C 1071 and the following, 2-inch thick, black insulation in rolls as long as available, meeting ASTM C 1071, with the following characteristics:

1. Fire hazard: ASTM E 84, flame spread 25 or less; smoke development 50 or less.
2. Smoke opacity: ASTM E 662.
3. ATM E 162: Exceeds requirements for surface flammability.

B. Accessories:

1. Impaling pins and clips: Cemco 1500 Series, Tactoo Insul-Hangers Series T by AGM Industries, Inc. or equal by Eckel Industries, Inc., of appropriate length required for insulation thickness used.
2. Adhesive for impaling pins: Made, or approved by the clip manufacturer. Do not use "peel and press" hangers with self-adhesive back.
3. Caps: Spun aluminum caps fitting pin size used.
4. Woven wire mesh: One-inch, 20-gage "Stucco Netting" 1-1/2-inch by 17-gage, zinc-coated hexagonal woven wire netting consisting of woven wire 1/18-inch diameter, by Davis Wire, "Keymesh Stucco Netting" by Keystone Steel & Wire Co., "SF Netting" by K-Lath, or equal complying with ASTM A 641 and C 1032. Paint black before installation, and touchup damaged paint when installed.]

2.04 ACOUSTIC SEALANTS & TAPE

A. Bulk sealant for closing small openings and joints up to a maximum of one-inch wide. Sealant backed with glass fiber packing, compressible joint filler or resilient backer rod. Do not use acetoxysilicone sealant where it might contact copper pipes.

1. Products:
 - a. Pecora Corp.: AC-20.
 - b. US Gypsum Co.: Sheetrock Acoustical Sealant.
 - c. Tremco, Inc.: Acoustical Sealant.
 - d. OSI Sealants: Henkel Corporation: OSI Pro-Series SC-175 Acoustical Sound Sealant.

B. Fire-barrier (acoustical) putty:

1. For closing large openings and joints typically over one inch wide. Applied full depth or backed with a dense safin, as detailed.
2. Non-shrinking, highly-adhesive, minimum 40-pcf density fire-barrier putty.
3. Products:
 - a. Series SSP Firestop Putty and Putty Pads by Specified Technologies Inc.
 - b. Nelson FSP Firestop Intumescent Putty by Chargar Corp.
 - c. Fiberfrax Fyre Putty by Unifrax.
 - d. Hilti CP 617 and CP 617L, intumescent moldable firestop putty for electrical outlet boxes.

C. Foamed-in-place silicone sealant:

1. For closing electrical ducts and cable trays where they penetrate constructions. Apply full depth of construction between permanent or temporary dams.
2. Fire-resistant, minimum 17-pcf density, foamed-in-place silicone sealant.
3. Products: Fire Barrier 2001 Silicone RTV Foam by 3M Fire Barrier Products Division.

D. Fire-resistive acoustic foam tape: "Norseal V740FR" compressible, closed cell polyvinyl chloride foam tape with pressure sensitive adhesive by Saint Gobain, or equal.

1. Provide one-inch wide by not less than 1/4-inch thick, self-extinguishing, 6 pcf density UL-listed acoustical foam tape.
2. Furnish tape in rolls with protective release liner on non-adhesive face.

2.05 ACOUSTIC PADS

- A. Use: For sealing the backs and sides of standard electrical back boxes. Select size to completely cover the box and overlap wall facing material at least one-inch.
1. Fire-rated assemblies:
 - a. Flamesafe FSP 1077 Putty Pads by WR Grace & Co.
 - b. Putty Pads by Specified Technologies Inc.
 - c. Hilti CP617 Putty Pads by Hilti.
 - d. 3M Fire Barrier Moldable Putty Pads by RectorSeal.
 - e. Putty Pads by International Protective Coatings.
 2. Elsewhere:
 - a. Type FSP Firestop Putty Pads by Nelson Electric.
 - b. Lowry's Outlet Box Pads by Harry A. Lowry & Associates.
 - c. Sound Pad #68 by L.H. Dottie Co.
- B. Self-adhesive sponge neoprene pads:
1. For providing a compressible filler and acoustical seal in the gaps of slip joints. Set in place with 10 to 15 percent compression. Airtight splices work in length-wise direction.
 2. Closed-cell sponge or foam neoprene of 8- to 12-pcf density, self-adhesive on one side, thicknesses and widths as required.
 3. Products:
 - a. Type V760 Norseal Foam Sealants by American Saint-Gobain.
 - b. DS Brown Co.
- C. Felt-lined metal sleeves:
1. For sealing around pipe, hanger rod or other round element penetrating a construction. Inside sleeve diameter to equal outside diameter of penetrating element. Exposed end of sleeve closed with acoustical sealant.
 2. Products:
 - a. Pipe Isolator by Eleen.
 - b. P-R Isolator by Potter-Roemer.
 - c. Trisolator by Stoneman Engineering.
- D. Self-adhesive bubble gaskets:
1. To seal around the edge of an operating access panels. Typically set on jamb or head frame or stop to act as a compression seal.
 2. Nominal 1/4-inch by 1/2-inch compressible bulb of silicone rubber or polyprene with self-adhesive on one side.
 3. Products:

- a. 5050 Self-Adhesive Gasket by National Guard Products.
- b. S88D or S88W Siliconeal by Pemko.
- c. 797 or 797W by Reese Enterprises.

PART 3 EXECUTION

3.01 EXAMINATION/PREPARATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Before installing insulation in stud walls, thoroughly clean space of debris.
- C. Correct detrimental conditions before proceeding with installation.

3.02 ACOUSTIC PADS

- A. Install acoustic pads behind all recessed boxes in walls that have acoustical insulation in their stud cavities.
- B. Clean the contact area of loose and foreign material in accordance with the pad manufacturer's instructions.
- C. Verify that all unused knockouts are plugged before installing the pad.
- D. Center the pad and cover the back and sides of all electrical, telephone and CATV boxes in sound-insulated walls with the acoustical pad.
- E. Mold around conduits and cables entering the box.
- F. Mold pads tightly to the boxes and to the adjacent surfaces.

3.03 BATT INSULATION

- A. Cut to fit irregular spaces, butt edges into firm contact with each other and adjoining surfaces.
- B. Hand pack around pipes, ducts, conduits, electrical boxes, etc., as required to thoroughly fill all voids and spaces between framing members and to form a continuous acoustical barrier.
- C. Comply with the California Electrical Code (CEC) for installation in proximity to light fixtures. Do not install insulation closer than recommended by CEC.
- D. Where in-wall electrical conduit is parallel to the wall, slit the insulation halfway to bury the conduit in it. Where the conduit is perpendicular to the wall (penetration), do not oversize the penetration; tape the conduit to prevent sound leakage.
- E. For application above ceilings, select batt width to be supported on ceiling construction over entire ceiling.

3.04 BOARD INSULATION

- A. Attach insulation to solid surfaces as follows:
 1. Where indicated, provide 2 layers of insulation; stagger joints between layers.

2. Provide insulation fasteners at typical spacing specified, or equivalent area for panels of a different size and for any cut panel sizes, except not less than 2 fasteners for any single piece.
 3. Lay out insulation without single piece less than 24 inches wide or less than 48 inches long, unless otherwise limited by available space.
 4. Offset intermediate end joints in adjacent panels and between insulation layers not less than 12 inches.
 5. For 48-inch wide units follow insulation manufacturer's instructions. Provide a minimum of 8 fasteners. Space edge fasteners no more than 3-inch from edges.
 6. For 24-inch wide units, comply with the above, except use no less than 6 fasteners.
 7. Secure each metal clip base in full bed of adhesive as recommended by their manufacturer.
 8. Do not install panels until clip adhesive is fully set.
 9. Cut panels in straight lines using sharp knives to prevent fraying. If necessary, neatly and carefully precut small slots through panels to facilitate placing insulation over fasteners.
 10. Install panels fully bearing against substrates, and neatly and tightly fitted at joints and around surfaces of penetrations.
 11. Install fastener caps firmly against panel faces and without compressing insulation.
- B. Cover insulation with woven wire mesh from wood base to height indicated; keep top of mesh level throughout the room. Staple at 6 inches o.c to supports.
- 3.05 ACOUSTIC SEALANT
- A. Comply with ASTM C 919 and the following.
 - B. Clean space to be calked of debris, dust and powdered materials which would prevent the sealant from adhering properly.
 - C. Seal openings between gypsum board and the perimeter of items penetrating gypsum board, such as electrical boxes, continuously using sealant specified.
 - D. Seal openings between the gypsum board and floors and ceilings along sound-insulated walls continuously, and along those intersecting walls for a minimum distance of 3-foot from insulated walls. When multiple layers occur, seal the perimeter of each layer continuously.
 - E. Seal gypsum board edges in contact with door frames continuously.
- 3.06 FIELD QUALITY CONTROL
- A. Prior to closing-in of insulated assemblies, or prior to Substantial Completion for insulation that will remain exposed in the building, refit, reinstall and/or replace wet, damaged and displaced insulation.

END OF SECTION

SECTION 09 90 00

PAINTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Primers.
2. Finish coatings.
3. Floor sealers and paints.

B. Following items shall not be painted:

1. Brass valves, chromium or nickel-plated piping and fittings.
2. Fabric connections to fans.
3. Flexible conduit connections to equipment, miscellaneous name plates, stamping and instruction labels and manufacturer's data.
4. Mechanical and electrical utility lines, piping and heating and ventilation ductwork in tunnels, underfloor excavated areas or crawl spaces, attic spaces and enclosed utility spaces.
5. Products and equipment having a complete factory finish.
6. Brass, bronze, aluminum, lead, stainless steel, and chrome or nickel-plated surfaces.

C. Related Requirements:

1. [Section 05 12 00 "Structural Steel Framing"] [Section 05 12 13 "Architecturally Exposed Structural Steel Framing"] for shop priming of metal substrates.
2. Section 05 50 00 "Metal Fabrications" for shop priming metal fabrications.
3. Section 05 51 13 "Metal Pan Stairs" for shop priming metal floor plate stairs.
4. Section 05 51 19 "Metal Grating Stairs" for shop priming metal grating stairs.
5. Section 05 52 13 "Pipe and Tube Railings" for shop **[priming]** **[painting]** pipe and tube railings.
6. Section 09 96 00 "High-Performance Coatings" for Interior and Exterior substrates, and tilelike coatings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

- D. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- E. Product Schedule: Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.03 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint Products: **[5]** <Insert number> percent, but not less than **[1 gal.]** <Insert value> of each material and color applied.

1.04 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - a. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.06 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain each paint product from single source from single manufacturer.

B. PAINT

1. See current Campus Standards for acceptable Painting Manufacturers.

C. GRAFFITI-RESISTANT COATING

1. Permashield Premium
2. PROSOCO
3. Rainguard International

2.02 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

B. Colors: [As selected by Architect from manufacturer's full range] [Match Architect's samples] [As indicated in a color schedule] <Insert requirements>.

1. **[10] [20] [30]** <Insert number> percent of surface area will be painted with deep tones.
2. LACC
 - a. Navajo White formula should be Vista formula. Swiss coffee eggshell preferred on all common walls for ease of maintenance. Use stock colors if possible on select areas for ease of maintenance. SCHOOL COLORS: Hyper Blue, Molasses, Crimson Red.
3. LAPC
 - a. Interior walls in classrooms, hallways, bathrooms and doors shall be Dunn Edwards suprema semigloss or similar. Ultra low voc or zero voc. Off white color shall be swiss coffee.
 - b. Exterior: dunn edwards evershield or similar. All trim (wood and metal) shall use semi-gloss paint.

C. Gloss degree standards shall be as follows:

- | | | | |
|---------------|--------------|----------|----------|
| 1. HIGH-GLOSS | 70 and above | EGGSHELL | 30 to 47 |
| 2. SEMI-GLOSS | 48 to 69 | FLAT | 15 to 29 |

2.03 PRIMERS

A. Exterior, Alkali-Resistant, Water-Based Primer: Pigmented, water-based primer formulated for use on alkaline surfaces, such as exterior plaster, vertical concrete, and masonry.

B. Exterior Wood Preservative: Solvent-based, zinc or copper naphthenate, penetrating antifungal treatment for exterior wood.

- C. Exterior, Latex Wood Primer: White, waterborne-emulsion primer formulated for resistance to extractive bleeding, mold, and microbials; for hiding stains; and for use on exterior wood subject to extractive bleeding.
- D. Exterior, Alkyd/Oil Wood Primer: Alkyd/oil-based primer that is resistant to extractive bleeding when applied to wood substrates with less than 15 percent moisture content; formulated for sag, mold, and microbial resistance; for hiding stains; and for use on exterior wood subject to extractive bleeding.
- E. Exterior, Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of exterior concrete masonry units in preparation for specified subsequent coatings.
 - 1. Minimum Solids Content: [Manufacturer's standard percentage] [50 percent] <Insert requirements> solids by volume.
- F. Water-Based Bonding Primer: Pigmented, water-based-emulsion primer formulated for exterior use and to promote adhesion of subsequent specified coatings.
- G. Solvent-Based Bonding Primer: Pigmented, solvent-based primer formulated for exterior use and to seal substrates and promote adhesion of specified subsequent coatings.
- H. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, exterior ferrous metals subject to mildly corrosive environments.
- I. Zinc-Rich, Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer formulated for use on prepared steel subject to severe industrial or marine environments.
- J. Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on structural steel and metal fabrications that have been minimally prepared.
- K. Quick-Drying, Alkyd Metal Primer: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, exterior steel surfaces.
- L. Alkyd Metal Primer: Corrosion-resistant, solvent-based, alkyd primer formulated for use on prepared ferrous metals subject to industrial and light marine environments.
- M. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.
- N. Epoxy Metal Primer: Corrosion-resistant, solvent-based, two-component epoxy primer formulated for use on prepared, exterior ferrous- and galvanized-metal surfaces.
- O. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid, wash primer formulated for use over cleaned metal surfaces and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.
- P. Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared exterior aluminum.

2.04 FINISH COATINGS

- A. Exterior Latex Paint, Flat: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as portland cement plaster, concrete, and primed wood.
- B. Exterior Latex Paint, Low Sheen: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as portland cement plaster, concrete, and primed wood.
- C. Exterior Latex Paint, Semigloss: Water-based, pigmented emulsion coating formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as masonry, portland cement plaster, and primed wood and metal.
 - 1. Gloss Level: [Manufacturer's standard semigloss finish] [Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523] <Insert requirements>.
- D. Exterior Latex Paint, Gloss: Water-based, pigmented, acrylic-copolymer-emulsion coating formulated for alkali, mold, microbial, scrub, blocking (sticking of two painted surfaces), and water resistance and for use on exterior, primed, wood and metal trim, sashes, frames, and doors.
 - 1. Gloss Level: [Manufacturer's standard gloss finish] [Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523] <Insert requirements>.
- E. Exterior, High-Build Latex Paint: Water-based, high-build, pigmented, emulsion coating; high-solids content improves filling, uniformity, and film build on concrete masonry surfaces. Formulated for abrasion, mold, microbial, and wind-driven rain resistance and for use on exterior masonry, concrete masonry unit, and concrete surfaces.
 - 1. Minimum Solids Content: [Manufacturer's standard percentage] [47 percent] <Insert requirements> solids by volume.
- F. Textured Latex Coating, Flat: Water-based, pigmented coating that contains sand or other hard aggregate and is formulated for use on exterior masonry, concrete masonry unit, and concrete surfaces.
 - 1. Aggregate Size: [Manufacturer's standard] [Fine] [Medium] [Coarse] <Insert requirements>.
- G. Textured Latex Coating, Low Sheen: Water-based, pigmented coating that contains sand or other hard aggregate and is formulated for use on exterior masonry, concrete masonry unit, and concrete surfaces.
 - 1. Aggregate Size: [Manufacturer's standard] [Fine] [Medium] [Coarse] <Insert requirements>.
- H. Exterior Alkyd Enamel, Flat: Solvent-based, pigmented, alkyd enamel formulated for mold, microbial, and water resistance and for use on exterior, primed, wood and metal surfaces.
- I. Exterior Alkyd Enamel, Semigloss: Solvent-based, pigmented, alkyd enamel formulated for mold, microbial, and water resistance and for use on exterior, primed, wood and metal surfaces.
 - 1. Gloss Level: [Manufacturer's standard semigloss finish] [Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523] <Insert requirements>.
- J. Exterior Alkyd Enamel, Gloss: Solvent-based, pigmented, alkyd enamel formulated for mold, microbial, and water resistance and for use on exterior, primed, wood and metal surfaces.
 - 1. Gloss Level: [Manufacturer's standard gloss finish] [Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523] <Insert requirements>.

2. Fineness of Grind: **[Manufacturer's standard]** **[Maximum fineness of pigment dispersion of 6 units when tested in accordance with ASTM D1210]** **<Insert requirements>**.
- K. Quick-Drying Alkyd Enamel, Semigloss: Solvent-based, alkyd or modified-alkyd enamel formulated for quick-drying capabilities and for use on exterior, primed, metal and dimensionally stable wood surfaces.
1. Gloss Level: **[Manufacturer's standard semigloss finish]** **[Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523]** **<Insert requirements>**.
- L. Quick-Drying Alkyd Enamel, Gloss: Solvent-based, alkyd or modified-alkyd enamel formulated for quick-drying capabilities and for use on exterior, primed, metal and dimensionally stable wood surfaces.
1. Gloss Level: **[Manufacturer's standard gloss finish]** **[Minimum gloss of 85 units at 60 degrees when tested in accordance with ASTM D523]** **<Insert requirements>**.
- M. Aluminum Paint: Aliphatic, solvent-based coating consisting of varnish or alkyd binder combined with aluminum pigment that is formulated for use as a stain-blocking coating and sealer on exterior wood, metal, bituminous-coated, and prepared masonry surfaces and to be able to be recoated with conventional alkyd and latex paints.
- N. High-Build Epoxy Paint, Low Gloss: High-solids, two-component epoxy; formulated for use on exterior concrete, masonry, and primed-metal surfaces.
- O. Exterior, Water-Based, Light Industrial Coating, Low Sheen: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.
- P. Exterior, Water-Based, Light Industrial Coating, Semigloss: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.
1. Gloss Level: **[Manufacturer's standard semigloss finish]** **[Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523]** **<Insert requirements>**.
- Q. Exterior, Water-Based, Light Industrial Coating, Gloss: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.
1. Gloss Level: **[Manufacturer's standard gloss finish]** **[Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523]** **<Insert requirements>**.
- 2.05 FLOOR SEALERS AND PAINTS
- A. Latex Floor Paint, Low Gloss: Water-based, pigmented coating formulated to hide stains, for alkali and incidental water resistance, and for use on exterior, concrete and primed-wood surfaces subject to low to medium foot traffic.
1. Gloss and Sheen Level: **[Manufacturer's standard low-gloss finish]** **[Maximum gloss of 25 units at 60 degrees and sheen of 10 to 35 units at 85 degrees when tested in accordance with ASTM D523]** **<Insert requirements>**.
 2. Slip-Resistant Aggregate: **[Manufacturer's standard additive]** **<Insert requirements>**.

- B. Latex Deck Coating: Water-based, high-solids, acrylic-emulsion coating; formulated for use on exterior, concrete and wood-board traffic surfaces.
 - 1. Gloss Level: **[Manufacturer's standard]** <Insert requirements>.
 - 2. Minimum Solids Content: **[Manufacturer's standard percentage]** **[25 percent]** <Insert requirements> solids by volume.
 - 3. Surface Texture: **[Smooth]** **[Slip resistant]**.
- C. Alkyd Floor Enamel, Gloss: Solvent-based, alkyd enamel; self-priming where applied to bare wood; formulated to hide stains, for durability, for microbial and abrasion resistance, and for use on exterior, wood-board, traffic surfaces.
 - 1. Gloss Level: **[Manufacturer's standard gloss finish]** **[Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523]** <Insert requirements>.
 - 2. Slip-Resistant Aggregate: **[Manufacturer's standard additive]** <Insert requirements>.
- D. Water-Based, Concrete-Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on exterior, concrete traffic surfaces.
- E. Solvent-Based, Concrete-Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on exterior, concrete traffic surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Fiber-Cement Board: 12 percent.
 - 3. Masonry (Clay and Concrete Masonry Units): 12 percent.
 - 4. Wood: 15 percent.
 - 5. Portland Cement Plaster: 12 percent.
 - 6. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is dry and sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
- G. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer **[.] [but not less than the following:]**
1. SSPC-SP 2.
 2. SSPC-SP 3.
 3. SSPC-SP 7/NACE No. 4.
 4. SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 2. Sand surfaces that will be exposed to view, and remove sanding dust.
 3. Prime edges, ends, faces, undersides, and backsides of wood.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.03 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint **[both sides] [exterior side]** and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards **[and switch gear]**.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. <Insert requirements>.

3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
 - 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 EXTERIOR PAINTING SCHEDULE

- A. Wood: 100 percent Acrylic Flat
 - 1. Primer (1 coat):
 - a. 4200 Terminator II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield by Dunn-Edwards.
 - c. Duration Flat K32 Series by Sherwin-Williams.
- B. Wood: 100 percent Semi-Gloss Acrylic
 - 1. Primer (1 coat):
 - a. 4200 Terminator II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. EVSH50-0 Evershield SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- C. Wood: 100 percent Gloss Acrylic

1. Primer (1 coat):
 - a. 4200 Terminator II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60-0 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- D. Wood: Semi-Transparent Stain
1. 2 Coats:
 - a. Olympic Maximum Semi-Transparent Stain by Vista Paint.
 - b. Okon WPT-3 Semi-Transparent Stain by Dunn-Edwards.
 - c. SuperDeck Exterior Waterborne Semi-Transparent Stain, SD3T00015 by Sherwin-Williams.
- E. Concrete and Brick: 100 percent Acrylic Flat
1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. Loxon Concrete & Masonry Primer/Sealer, A24W8300 by Sherwin-Williams.
 2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield by Dunn-Edwards.
 - c. Duration Flat K32 Series by Sherwin-Williams.
- F. Portland Cement Plaster: 100 percent Acrylic Flat
1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. Loxon Concrete & Masonry Primer/Sealer, A24W8300 by Sherwin-Williams.
 2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield by Dunn-Edwards.
 - c. Duration Flat K32 Series by Sherwin-Williams.
- G. CMU: 100 percent Acrylic Flat
1. Primer (1 coat):
 - a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.

- c. Loxon Block Surfacers, A24W200 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield by Dunn-Edwards.
 - c. Duration Flat K32 Series by Sherwin-Williams.
- H. CMU: 100 percent Acrylic Elastomeric
 - 1. Primer (1 coat):
 - a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.
 - c. Loxon Block Surfacers, A24W200 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 1900 Weather Master at 8 to 10 MILS per coat DFT by Vista Paint.
 - b. DE Enduralastic, 10 EDLX10-0 Elastomeric at 11 to 13 MILS per coat DFT by Dunn-Edwards.
 - c. Loxon XP, A24W1451 at 8 to 10 MILS per coat DFT by Sherwin-Williams.
- I. CMU, Concrete, Brick: Graffiti-Resistant Coating (Permanent Matte Flat)
 - 1. Graffiti resistant coating shall be a clear, non-sacrificial graffiti resistant coating which provides protection for exterior vertical surfaces from permanent graffiti staining and damage caused by spray paint and marking pens. Coating shall be suitable for application to painted and unpainted surfaces including masonry, concrete, metals, and EIFS. Product shall be of type such that recoating with the underlying paint is possible without removal of the graffiti resistant coating. Product shall be a coating that dries clear, non-yellowing, with a low luster.
 - a. Equivalent by PROSOCO.
 - b. Painted Surfaces
 - 1) Finish Coat – Opaque (2 coats):
 - (a) Monochem 6100 Clear or 6150 Pigmented TDFT Base at 4-6 MILS by Vista Paint.
 - (b) Monochem 6100 Clear or 6150 Pigmented TDFT Base at 4-6 MILS by Dunn-Edwards.
 - (c) Monochem 6100 Clear or 6150 Pigmented TDFT Base at 4-6 MILS by Sherwin-Williams.
 - 2) Finish Coat – Clear (2 coats):
 - (a) Monochem 5600 Permashield Premium at 4-6 MILS TDFT by Vista Paint.
 - (b) Monochem 5600 Permashield Premium at 4-6 MILS TDFT by Dunn-Edwards.
 - (c) Monochem 5600 Permashield Premium at 4-6 MILS TDFT by Sherwin-Williams.
 - (d) VandIGuard IsoFree Aliphatic 2K Non-Sacrificial Graffiti Coating (1 Coat at 3-4 wet mils) by RainGuard International.

- c. Graffiti Remover: VandIClean Super graffiti remover by Rainguard International.
- J. Iron and Steel: 100 percent Gloss Acrylic
- 1. Primer (1 coat):
 - a. 9600 Protec Primer by Vista Paint.
 - b. BRPR00 Block Rust by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60-0 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- K. Iron and Steel: 100 percent Semi-Gloss Acrylic
- 1. Primer (1 coat):
 - a. 9600 Protec Primer by Vista Paint.
 - b. BRPR00 Block Rust by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. EVSH50-0 Evershield GL by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- L. Aluminum and Galvanized Steel: 100 percent Gloss Acrylic
- 1. Pretreat:
 - a. Jasco Prep N Prime by Vista Paint.
 - b. SCME-01 Supreme Etch by Dunn-Edwards.
 - c. Great Lakes Clean & Etch by Sherwin-Williams.
 - 2. Primer (1 coat):
 - a. 4800 Metal Pro Primer by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. Pro Industrial DTM Acrylic Primer/Finish, B66W11 by Sherwin-Williams.
 - 3. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60-0 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- M. Aluminum and Galvanized Steel: 100 percent Semi-Gloss Acrylic
- 1. Pretreat:
 - a. Krud Kutter by Vista Paint.
 - b. SCME-01 Supreme Etch by Dunn-Edwards.

- c. Great Lakes Clean & Etch by Sherwin-Williams.
 - 2. Primer (1 coat):
 - a. 4800 Metal Pro Primer by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. Pro Industrial DTM Acrylic Primer/Finish, B66W11 by Sherwin-Williams.
 - 3. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. EVSH50-0 Evershield SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- N. Fiber Cement Board: 100 percent Acrylic Flat
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. Loxon Concrete & Masonry Primer/Sealer, A24W8300 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield by Dunn-Edwards.
 - c. Duration Flat K32 Series by Sherwin-Williams.
- O. Zinc Alloy: 100 percent Semi-Gloss Acrylic
- Pretreat:
- a. Krud Kutter by Vista Paint.
 - b. SCME-01 Supreme Etch by Dunn-Edwards.
 - c. Great Lakes Clean & Etch by Sherwin-Williams.
- 2. Primer (1 coat):
 - a. 4800 Metal Pro Primer by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. Pro Industrial DTM Acrylic Primer/Finish, B66W11 by Sherwin-Williams.
 - 3. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. EVSH50-0 Evershield SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- P. Ferrous Metal: Heavy Duty
- 1. Primer (1 coat):
 - a. Carboline Carboguard 890 VOC at 5 MILS DFT by Vista Paint.
 - b. Carboline Carboguard 890 VOC at 5 MILS DFT by Dunn-Edwards.
 - c. Macropoxy 646-100 Fast Cure Epoxy, B58W620 at 5 MILS DFT by Sherwin-Williams.

2. Primer (1 coat):
 - a. Carboline Carbothane 133MC at 5 MILS DFT by Vista Paint.
 - b. Carboline Carbothane 133MC at 5 MILS DFT by Dunn-Edwards.
 - c. Hi-Solids Polyurethane 100, B65-600 Series at 4 MILS DFT by Sherwin-Williams.

Q. Gypsum Soffit Board: 100 percent Acrylic Flat

1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
2. Finish Coat (2 coats):
 - a. 2000 Duratone by Vista Paint.
 - b. EVSH10 Evershield or Enduralastic 10 by Dunn-Edwards.
 - c. Duration Flat K32 Series or A80-1100 Series by Sherwin-Williams.

3.07 INTERIOR PAINT SCHEDULE

A. Wood: Low Sheen 100 percent Acrylic

1. Primer (1 coat):
 - a. 4200 Terminator II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
2. Finish Coat (2 coats):
 - a. 8200 Carefree by Vista Paint.
 - b. SPMA20 Suprema Velvet Sheen by Dunn-Edwards.
 - c. Duration Matte A96 Series by Sherwin-Williams.

B. Wood: Semi-Gloss 100 percent Acrylic

1. Primer (1 coat):
 - a. 4200 Terminator II by Vista Paint.
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. ProBlock Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
2. Finish Coat (2 coats):
 - a. 8400 Carefree Semi-Gloss by Vista Paint.
 - b. SPMA50 Suprema Semi-Gloss by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.

C. Wood: ST Stain & Clear Lacquer Finish (275 g/liter VOC)

1. Stain (1 coat):
 - a. VWS0250 Series ST Stain by Vista Paint.

- b. Old Masters Water-bases Stain by Dunn-Edwards.
- c. Minwax Water-based Wood Stain by Sherwin-Williams.
- 2. Sanding Sealer (1 coat):
 - a. NRS 1620 [? ? ?] by Vista Paint.
 - b. Contractor's Edge Sanding Sealer by Dunn-Edwards.
 - c. Sher-Wood NC Lacquer Sealer, T65FV14 Sanding Sealer by Sherwin-Williams.
- 3. Finish (1 coat):
 - a. NRF 1626 Satin Lacquer by Vista Paint.
 - b. Contractor's Edge Sanding Sealer by Dunn-Edwards.
 - c. Sher-Wood 275 Lacquer, T75FH100 Series by Sherwin-Williams.
 - d. Wood: Stained, Water White Finish (for light colored stains) (275 g/liter VOC)
- 4. Stain (1 coat):
 - a. VW0250 Series ST Stain by Vista Paint.
 - b. Gemini 240 Wiping Stain 2400 by Dunn-Edwards.
 - c. Minwax Water-based Wood Stain by Sherwin-Williams.
- 5. Sealer (1 coat):
 - a. NAF 1420 Satin Sealer by Vista Paint.
 - b. Gemini Lacquer Sealer 700-1200 by Dunn-Edwards.
 - c. Sher-Wood NC Lacquer by Sherwin-Williams.
- 6. Finish (1 coat):
 - a. NAF 1426 Satin Lacquer by Vista Paint.
 - b. Gemini Clear Lacquer 500-0282 by Dunn-Edwards.
 - c. Sher-Wood 275 Lacquer, T75FH100 Series by Sherwin-Williams.
- D. Wood: Varnish Flat Clear
 - 1. Finish Coat (2 coats):
 - a. McCloskey's 6701 Flat by Vista Paint.
 - b. Old Masters Waterborne Wood Stain by Dunn-Edwards.
 - c. Minwax Water based Wood Stain by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. Varnish Satin Clear McCloskey's 6702 Satin by Vista Paint.
 - b. Old Masters Waterborne Polyurethane Satin by Dunn-Edwards.
 - c. Wood Classics Waterborne Polyurethane Varnish Satin by Sherwin-Williams.
 - 3. Finish Coat (2 coats):
 - a. Varnish Gloss Clear McCloskey's 6703 Gloss by Vista Paint.
 - b. Old Masters Waterborne Polyurethane Gloss by Dunn-Edwards.
 - c. Wood Classics Waterborne Polyurethane Varnish Gloss by Sherwin-Williams.
 - d. Wood: Varnish Flat Clear

4. Finish Coat (2 coats):
 - a. DF 12 Dryfall Flat by Vista Paint.
 - b. AQUA10 Aquafall Dry Fall by Dunn-Edwards.
 - c. Waterborne Acrylic Dryfall Flat, B42W1 by Sherwin-Williams.
 - d. Rough Sawn Wood: Stain, Semi-Transparent
 5. Finish Coat (2 coats):
 - a. Olympic Semi-Transparent Stain by Vista Paint.
 - b. Okon WPT-3 Semi-Transparent Stain by Dunn-Edwards.
 - c. Transparent Stain Waterborne Semi-Transparent Stain, SD3T00015 by Sherwin-Williams.
- E. Concrete, Plaster, CMU: Flat Acrylic
1. Concrete Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 2. Plaster Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 3. CMU Primer (1 coat):
 - a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.
 - c. Loxon Block Surfacer, A24W200 by Sherwin-Williams.
 4. Finish Coat (2 coats):
 - a. 8100 Carefree Flat by Vista Paint.
 - b. SPMA10 Suprema Flat by Dunn-Edwards.
 - c. Duration Flat A95 Series by Sherwin-Williams.
- F. CMU, Concrete, Plaster: Eggshell Acrylic
1. Concrete Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 2. Plaster Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 3. CMU Primer (1 coat):

- a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.
 - c. Loxon Block Surfacer, A24W200 by Sherwin-Williams.
4. Finish Coat (2 coats):
- a. 8200 Carefree VS by Vista Paint.
 - b. SPMA30 Suprema EG by Dunn-Edwards.
 - c. Duration Matte A96 Series by Sherwin-Williams.
- G. CMU, Concrete, Plaster: Semi-Gloss Acrylic
1. Concrete Primer (1 coat):
- a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
2. Plaster Primer (1 coat):
- a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
3. CMU Primer (1 coat):
- a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.
 - c. Loxon Block Surfacer, A24W200 by Sherwin-Williams.
4. Finish Coat (2 coats):
- a. 8400 Carefree SG by Vista Paint.
 - b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- H. CMU, Concrete, Plaster: 100 percent Acrylic
1. Concrete Primer (1 coat):
- a. 065 Acry-Prime by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
2. Plaster Primer (1 coat):
- a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
3. CMU Primer (1 coat):
- a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.

- c. Loxon Block Surfacers, A24W200 by Sherwin-Williams.
 - 4. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- I. Masonry: Gloss Acrylic Epoxy
 - 1. Concrete Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Loc or Carboline 120 Primer with Carboline Sanitile 555 by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Plaster Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Super-Loc by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 3. CMU Primer (1 coat):
 - a. 018 Acrylic Block Filler by Vista Paint.
 - b. SBPR00 Blocfil by Dunn-Edwards.
 - c. Loxon Block Surfacers, A24W200 by Sherwin-Williams.
 - 4. Finish Coat (2 coats):
 - a. S60 WB Gloss Epoxy at 2 to 3 MILS DFT by Vista Paint.
 - b. S60 WB Gloss Epoxy at 2 to 3 MILS DFT or Carboline Sanitile 555 by Dunn-Edwards.
 - c. Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300/B73V300 at 2 to 4 MILS DFT by Sherwin-Williams.
- J. Gypsum Board: Flat
 - 1. Finish Coat (2 coats):
 - a. 8100 Carefree Flat by Vista Paint.
 - b. SPMA10 Suprema Flat by Dunn-Edwards.
 - c. Duration Flat A95 Series by Sherwin-Williams.
- K. Gypsum Board: Eggshell
 - 1. Primer (1 coat):
 - a. 1100 Hi-Build PVA Primer by Vista Paint.
 - b. VNPR00 Vinylastic Primer by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Primer, B28W2600 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8200 Carefree Velva Sheen by Vista Paint.
 - b. SPMA30 Suprema EG by Dunn-Edwards.

- c. Duration Matte A96 Series by Sherwin-Williams.
- L. Gypsum Board: Low Sheen 100 percent Acrylic
 - 1. Primer (1 coat):
 - a. 1100 Hi-Build PVA Primer by Vista Paint.
 - b. VNPR00 Vinylastic Primer by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Primer, B28W2600 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8300 Carefree Eggshell by Vista Paint.
 - b. SPMA40 Suprema Low Sheen by Dunn-Edwards.
 - c. Duration Satin A97 Series by Sherwin-Williams.
- M. Gypsum Board: Semi-Gloss Acrylic
 - 1. Primer (1 coat):
 - a. 1100 Hi-Build PVA Primer by Vista Paint.
 - b. VNPR00 Vinylastic Primer by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Primer, B28W2600 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree Semi-Gloss by Vista Paint.
 - b. SPMA50 Suprema Semi-Gloss by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- N. Gypsum Board: 100 percent Gloss Acrylic
 - 1. Primer (1 coat):
 - a. 1100 Hi-Build PVA Primer by Vista Paint.
 - b. VNPR00 Vinylastic Primer by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Primer, B28W2600 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60 Evershield Gloss by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- O. Gypsum Board: Gloss Acrylic Epoxy
 - 1. Primer (1 coat):
 - a. 1100 Hi-Build PVA Primer by Vista Paint.
 - b. VNPR00 Vinylastic Primer by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Primer, B28W2600 by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. Carboline Sanitile 255 at 2 to 3 MILS DFT by Vista Paint.
 - b. Carboline Sanitile 255 at 2 to 3 MILS DFT by Dunn-Edwards.

- c. Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300/B73V300 at 2 to 4 MILS DFT by Sherwin-Williams.
- P. Plaster: Gypsum, Portland Cement, Flat
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8100 Carefree Flat by Vista Paint.
 - b. SPMA10 Suprema Flat by Dunn-Edwards.
 - c. Duration Flat, A95 Series by Sherwin-Williams.
- Q. Plaster: Gypsum, Portland Cement, Eggshell
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8200 Carefree Velva Sheen by Vista Paint.
 - b. SPMA30 Suprema EG by Dunn-Edwards.
 - c. Duration Matte A96 Series by Sherwin-Williams.
- R. Plaster: Gypsum, Portland Cement, Semi-Gloss Acrylic
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- S. Plaster: Gypsum, Portland Cement, Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.

- b. EVSH00 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss A38 Series by Sherwin-Williams.
- T. Particleboard, Hardboard: Flat
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8100 Carefree Flat by Vista Paint.
 - b. SPMA10 Suprema Flat by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Flat, B30-2600 by Sherwin-Williams.
- U. Particleboard, Hardboard: Semi-Gloss Acrylic
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 by Sherwin-Williams.
- V. Particleboard, Hardboard: Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 4600 Uniprime II by Vista Paint.
 - b. ESPR00 Eff-Stop by Dunn-Edwards.
 - c. ProBlock Interior/Exterior Latex Primer/Sealer, B51-600 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss A38 Series by Sherwin-Williams.
- W. Ferrous Metal: Semi-Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 9600 Protec Primer by Vista Paint
 - b. ENPR00 Enduraprime by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.

- b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- X. Ferrous Metal: Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 9600 Protec Primer by Vista Paint
 - b. BRPR00 Block-Rust by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH00 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss A38 Series by Sherwin-Williams.
- Y. Ferrous Metal: Heavy Duty
- 1. Primer (1 coat):
 - a. Carboline Carboguard 890 VOC at 5 MILS DFT by Vista Paint.
 - b. Carboline Carboguard 890 VOC at 5 MILS DFT by Dunn-Edwards.
 - c. Macropoxy 646-100 Fast Cure Epoxy, B58W620 at 5 MILS DFT by Sherwin-Williams.
 - 2. Primer (1 coat):
 - a. Carboline Carbothane 133MC at 5 MILS DFT by Vista Paint.
 - b. Carboline Carbothane 133MC at 5 MILS DFT by Dunn-Edwards.
 - c. Hi-Solids Polyurethane 100, B65-600 Series at 4 MILS DFT by Sherwin-Williams.
- Z. Aluminum: Semi-Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 9600 Protec Primer by Vista Paint
 - b. ULGM00 Ultrashield by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8400 Carefree SG by Vista Paint.
 - b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- AA. Aluminum: Gloss 100 percent Acrylic
- 1. Primer (1 coat):
 - a. 4800 Metal Pro Primer by Vista Paint
 - b. ULGM00 Ultrashield by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
 - 2. Finish Coat (2 coats):
 - a. 8500 Carefree Gloss by Vista Paint.

- b. EVSH60 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
 - d. Stainless Steel, Copper, Brass: Semi-Gloss 100 percent Acrylic
3. Primer (1 coat):
- a. 4800 Metal Pro Primer by Vista Paint
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
4. Finish Coat (2 coats):
- a. 8400 Carefree SG by Vista Paint.
 - b. SPMA50 Suprema SG by Dunn-Edwards.
 - c. Duration Semi-Gloss A98 Series by Sherwin-Williams.
- BB. Stainless Steel, Copper, Brass: Gloss 100 percent Acrylic
1. Primer (1 coat):
- a. 4800 Metal Pro Primer by Vista Paint
 - b. UGPR00 Ultra Grip Primer by Dunn-Edwards.
 - c. Pro Industrial Pro-Cryl Universal Primer, B66-310 Series by Sherwin-Williams.
2. Finish Coat (2 coats):
- a. 8500 Carefree Gloss by Vista Paint.
 - b. EVSH60 Evershield GL by Dunn-Edwards.
 - c. Duration Gloss K38 Series by Sherwin-Williams.
- CC. Fiberglass or Glass: (All Finishes)
1. Primer (1 coat):
- a. XIM Clear Primer by Vista Paint
 - b. XIM Clear Primer by Dunn-Edwards.
 - c. Extreme Bond Bonding Primer, B51W150 by Sherwin-Williams.
2. Finish Coat (2 coats):
- a. Finish as specified by Vista Paint.
 - b. Finish as specified by Dunn-Edwards.
 - c. Finish as specified by Sherwin-Williams.
- DD. Acoustical Tile: Flat
1. Primer (1 coat):
- a. 013 Acoustic Kote by Vista Paint
 - b. CEIL10 Ceiling Paint by Dunn-Edwards.
2. Finish Coat (2 coats):
- a. 013 Acoustic Kote by Vista Paint.
 - b. CEIL10 Ceiling Paint by Dunn-Edwards.

END OF SECTION

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SECTION 09 96 00

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems **[.] [on the following substrates:]**

- 1. Exterior Substrates:

- a. Concrete, **[vertical] [and] [horizontal]** surfaces.
- b. Fiber-cement board.
- c. Clay masonry.
- d. Concrete masonry units (CMUs).
- e. Steel.
- f. Galvanized metal.
- g. Aluminum (not anodized or otherwise coated).
- h. Copper.
- i. Stainless steel.
- j. Wood.
- k. Fiberglass.
- l. Portland cement plaster (stucco).

- 2. Interior Substrates:

- a. Concrete, **[vertical] [and] [horizontal]** surfaces.
- b. Cement board.
- c. Clay masonry.
- d. Concrete masonry units (CMUs).
- e. Steel.
- f. Galvanized metal.
- g. Aluminum (not anodized or otherwise coated).
- h. Wood.
- i. Fiberglass.
- j. Gypsum board.
- k. Plaster.

B. Related Requirements:

1. [Section 05 12 00 "Structural Steel Framing"] [Section 05 12 13 "Architecturally Exposed Structural Steel Framing"] for shop priming of structural steel with primers specified in this Section.
2. Section 05 52 13 "Pipe and Tube Railings" for shop **[priming] [painting]** pipe and tube railings with coatings specified in this Section.
3. Section 09 91 13 "Exterior Painting" for general field painting.
4. Section 09 91 23 "Interior Painting" for general field painting.

1.03 DEFINITIONS

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 1. Submit Samples on rigid backing, 8 inches square.
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials **[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Coatings: **[5] <Insert number>** percent, but not less than **[1 gal.] <Insert number>** of each material and color applied.

1.06 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.08 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, see Campus Standards for acceptable Paint Manufacturers listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.

2.02 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: [As selected by Architect from manufacturer's full range] [Match Architect's samples] [As indicated in color schedule] <Insert requirements>.

2.03 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.
 4. Wood: 15 percent.
 5. Gypsum Board: 12 percent.
 6. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of **[1500 to 4000 psi] [000 to 10,000 psi]** at 6 to 12 inches.
 - 2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of **[100 to 600 psi] [1500 to 4000 psi]** at 6 to 12 inches.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer **[.] [but not less than the following:]**
 - 1. SSPC-SP 7/NACE No. 4.
 - 2. SSPC-SP 11.
 - 3. SSPC-SP 6/NACE No. 3.
 - 4. SSPC-SP 10/NACE No. 2.
 - 5. SSPC-SP 5/NACE No. 1.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.

2. Sand surfaces that will be exposed to view and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.

3.03 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 1. Use applicators and techniques suited for coating and substrate indicated.
 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.06 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy System **[MPI EXT 3.1D]**:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
2. Epoxy-Modified Latex System **[MPI EXT 3.1E]**:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [, **MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [, **MPI #115**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
3. Pigmented Polyurethane over Epoxy System **[MPI EXT 3.1M]**:
 - a. Prime Coat: Epoxy, matching intermediate coat.
 - b. Intermediate Coat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.

B. Concrete Substrates, Horizontal Surfaces:

1. Epoxy Non-Slip Deck Coating System **[MPI EXT 3.2C]**:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Epoxy deck coating (slip resistant) [, **MPI #82**].
 - 1) **<Insert manufacturer's name; product name or designation>**.

C. Cement Board Substrates:

1. Epoxy System **[MPI EXT 3.3E]**:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].

- 1) <Insert manufacturer's name; product name or designation>.
 2. Epoxy-Modified Latex System **[MPI EXT 3.3D]**
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) **[, MPI #215]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) **[, MPI #115]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 3. Pigmented Polyurethane over Epoxy System **[MPI EXT 3.3F]**:
 - a. Prime Coat: Epoxy, gloss **[, MPI #77]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, matching prime coat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) <Insert manufacturer's name; product name or designation>.
- D. Clay Masonry Substrates:
1. Epoxy System **[MPI EXT 4.1D]**:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss **[, MPI #77]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 2. Pigmented Polyurethane over Epoxy System **[MPI EXT 4.1J]**:
 - a. Prime Coat: Epoxy, matching intermediate coat.
 - b. Intermediate Coat: Epoxy, gloss **[, MPI #77]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) <Insert manufacturer's name; product name or designation>.
- E. CMU Substrates:
1. Epoxy System **[MPI EXT 4.2E]**:
 - a. Block Filler: Block filler, epoxy **[, MPI #116]**.
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss **[, MPI #77]**.

- 1) **<Insert manufacturer's name; product name or designation>.**
2. Pigmented Polyurethane over High-Build Epoxy System **[MPI EXT 4.2G]:**
 - a. Block Filler: Block filler, epoxy **[, MPI #116]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, high build, low gloss **[, MPI #108]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
- F. Steel Substrates:
 1. Epoxy System **[MPI EXT 5.1F]:**
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, high build, low gloss **[, MPI #108]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Topcoat: Epoxy, gloss **[, MPI #77]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 2. Epoxy over Self-Priming Epoxy System **[MPI EXT 5.1S]:**
 - a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss **[, MPI #77]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 3. Epoxy Deck Coating over Epoxy Primer and High-Build Epoxy System **[MPI EXT 5.1V]:**
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, high build, low gloss **[, MPI #108]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Topcoat: Epoxy deck coating **[, MPI #82]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**
 4. Epoxy Deck Coating over Self-Priming Epoxy System **[MPI EXT 5.1X]:**
 - a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
 - 1) **<Insert manufacturer's name; product name or designation>.**

- b. Topcoat: Epoxy deck coating [, MPI #82].
 - 1) <Insert manufacturer's name; product name or designation>.
- 5. Pigmented Polyurethane over Epoxy System [MPI EXT 5.1H]:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, MPI #101].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, gloss [, MPI #77].
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. [First and Second]Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.
- 6. Pigmented Polyurethane over High-Build Epoxy System [MPI EXT 5.1J]:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, MPI #101].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, high build, low gloss [, MPI #108].
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.
- 7. Pigmented Polyurethane over Self-Priming Epoxy System [MPI EXT 5.1T]:
 - a. Prime Coat: Epoxy, high build, self-priming [, MPI #120].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.
- 8. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System [MPI EXT 5.1P]:
 - a. Prime Coat: Primer, zinc rich, epoxy [, MPI #20].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, gloss [, MPI #77].
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.

9. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System **[MPI EXT 5.1G]:**
 - a. Prime Coat: Primer, zinc rich, epoxy [, **MPI #20**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, high build, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. **[First and Second]**Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 10. Pigmented Polyurethane over Inorganic Zinc-Rich Primer and High-Build Epoxy System **[MPI EXT 5.1L]:**
 - a. Prime Coat: Primer, zinc rich, inorganic [, **MPI #19**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, high build, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- G. Galvanized-Metal Substrates:
1. Epoxy System **[MPI EXT 5.3C]:**
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, **MPI #101**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 2. Pigmented Polyurethane over Epoxy Primer System **[MPI EXT 5.3L]:**
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, **MPI #101**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 3. Pigmented Polyurethane over Vinyl Wash Primer and Epoxy Primer System **[MPI EXT 5.3D]:**
 - a. Prime Coat: Primer, vinyl wash [, **MPI #80**].

- 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal [, MPI #101].
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. **[First and Second]**Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.
- H. Aluminum (Not Anodized or Otherwise Coated) Substrates:
1. Epoxy System **[MPI EXT 5.4E]**:
 - a. Prime Coat: Primer, vinyl wash [, MPI #80].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, MPI #77].
 - 1) <Insert manufacturer's name; product name or designation>.
 2. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.4B]**:
 - a. Prime Coat: Primer, vinyl wash [, MPI #80].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal [, MPI #101].
 - c. **[First and Second]**Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.
- I. Copper Substrates:
1. Epoxy System **[MPI EXT 5.5E]**:
 - a. Prime Coat: Primer, vinyl wash [, MPI #80].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, MPI #77].
 - 1) <Insert manufacturer's name; product name or designation>.
 2. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.5B]**:
 - a. Prime Coat: Primer, vinyl wash [, MPI #80].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal [, MPI #101].
 - c. **[First and Second]**Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, MPI #72].
 - 1) <Insert manufacturer's name; product name or designation>.

- J. Stainless-Steel Substrates:
1. Epoxy System **[MPI EXT 5.6D]**:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss **[, MPI #77]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 2. Pigmented Polyurethane System **[MPI EXT 5.6B]**:
 - a. Prime Coat: Primer, vinyl wash **[, MPI #80]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - c. **[First and Second]**Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
- K. Wood Substrates: Glued-laminated construction.
1. Pigmented Polyurethane System **[MPI EXT 6.1J]**:
 - a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
- L. Wood Substrates: Exposed framing.
1. Pigmented Polyurethane System **[MPI EXT 6.2J]**:
 - a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
- M. Wood Substrates: **[Wood trim] [Architectural woodwork] [Doors] [Windows] [Wood board siding] [and] [wood fences]**
1. Pigmented Polyurethane System **[MPI EXT 6.3H]**:
 - a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.

- c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].

- 1) **<Insert manufacturer's name; product name or designation>**.

N. Fiberglass Substrates:

1. Epoxy System [**MPI EXT 6.7F**]:

- a. Prime Coat: Epoxy, matching topcoat.
- b. Intermediate Coat: Epoxy, matching topcoat.
- c. Topcoat: Epoxy, gloss [**MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>**.

2. Epoxy-Modified Latex System [**MPI EXT 6.7E**]

- a. Prime Coat: Epoxy-modified latex, matching topcoat.
- b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
- c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [**MPI #215**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [**MPI #115**].

- 1) **<Insert manufacturer's name; product name or designation>**.

3. Pigmented Polyurethane over Epoxy System [**MPI EXT 6.7D**]:

- a. Prime Coat: Epoxy, matching intermediate coat.
- b. Intermediate Coat: Epoxy, gloss [**MPI #77**].
- c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- 1) **<Insert manufacturer's name; product name or designation>**.

O. Portland Cement Plaster Substrates:

1. Epoxy System [**MPI EXT 9.1D**]:

- a. Prime Coat: Epoxy, matching topcoat.
- b. Intermediate Coat: Epoxy, matching topcoat.
- c. Topcoat: Epoxy, gloss [**MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>**.

3.07 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy System [**MPI INT 3.1F**]:

- a. Prime Coat: Epoxy, matching topcoat.
- b. Intermediate Coat: Epoxy, matching topcoat.

- c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 2. Epoxy, High-Build System [**MPI INT 3.1P**]:
 - a. Prime Coat: High-build epoxy, matching topcoat (reduced).
 - b. Intermediate Coat: High-build epoxy, matching topcoat.
 - c. Topcoat: High-build epoxy, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: High-build epoxy, gloss [, **MPI #98**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 3. Epoxy-Modified Latex System [**MPI INT 3.1G**]:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [, **MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [, **MPI #115**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- B. Concrete Substrates, Horizontal Surfaces.
- 1. Epoxy System [**MPI INT 3.2C**]:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 2. Epoxy, High-Build System [**MPI INT 3.2L**]:
 - a. Prime Coat: High-build epoxy, matching topcoat (reduced).
 - b. Intermediate Coat: High-build epoxy, matching topcoat.
 - c. Topcoat: High-build epoxy, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: High-build epoxy, gloss [, **MPI #98**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 3. Pigmented Polyurethane System [**MPI INT 3.2D**]:
 - a. Prime Coat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.

- c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- 4. Clear (Two-Component) Polyurethane System [**MPI INT 3.2K**]:
 - a. Prime Coat: Two-component polyurethane matching topcoat.
 - b. Intermediate Coat: Two-component polyurethane, matching topcoat.
 - c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7) [**MPI #78**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- C. Cement Board Substrates:
 - 1. Epoxy System [**MPI INT 3.3E**]:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [**MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 2. Epoxy-Modified Latex System [**MPI INT 3.3D**]:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [**MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [**MPI #115**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- D. Clay Masonry Substrates:
 - 1. Epoxy System [**MPI INT 4.1F**]:
 - a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [**MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - 2. Epoxy-Modified Latex System [**MPI INT 4.1G**]:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [**MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [**MPI #115**].

- 1) **<Insert manufacturer's name; product name or designation>.**
3. Clear (Two-Component) Polyurethane System **[MPI INT 4.1K]:**
 - a. Prime Coat: Two-component polyurethane, matching topcoat.
 - b. Intermediate Coat: Two-component polyurethane, matching topcoat.
 - c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7) [, **MPI #78**].

1) **<Insert manufacturer's name; product name or designation>.**

E. CMU Substrates:

1. Epoxy System **[MPI INT 4.2F] [MPI INT 4.2G]:**
 - a. Block Filler: Block filler, latex, interior/exterior [, **MPI #4**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Block Filler: Block filler, epoxy [, **MPI #116**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Intermediate Coat: Epoxy, matching topcoat.
 - d. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
2. Epoxy, High-Build System **[MPI INT 4.2R]:**
 - a. Prime Coat: Epoxy block filler [, **MPI #116**].
 - b. Intermediate Coat: High-build epoxy, matching topcoat.
 - c. Topcoat: High-build epoxy, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - d. Topcoat: High-build epoxy, gloss [, **MPI #98**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
3. Epoxy-Modified Latex System **[MPI INT 4.2J]:**
 - a. Block Filler: Block filler, latex, interior/exterior [, **MPI #4**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [, **MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [, **MPI #115**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
4. Clear (Two-Component) Polyurethane System **[MPI INT 4.2Q]:**
 - a. Prime Coat: Two-component polyurethane, matching topcoat.
 - b. Intermediate Coat: Two-component polyurethane, matching topcoat.

- c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7) [, **MPI #78**].

- 1) **<Insert manufacturer's name; product name or designation>**.

F. Steel Substrates:

1. Epoxy System [**MPI INT 5.1L**]:

- a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, **MPI #101**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- b. Intermediate Coat: Epoxy, matching topcoat.

- c. Topcoat: Epoxy, gloss [, **MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>**.

2. High-Build Epoxy over Epoxy Zinc-Rich Primer System [**MPI INT 5.1P**]:

- a. Prime Coat: Primer, zinc-rich, epoxy [, **MPI #20**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- b. Intermediate Coat: Epoxy, high build, low gloss [, **MPI #108**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- c. Topcoat: Epoxy, gloss [, **MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- d. Topcoat: Epoxy, high-build, low gloss [, **MPI #108**].

- 1) **<Insert manufacturer's name; product name or designation>**.

3. Epoxy over Self-Priming Epoxy System [**MPI INT 5.1V**]:

- a. Prime Coat: Epoxy, high build, self-priming [, **MPI #120**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- b. Intermediate Coat: Epoxy, matching topcoat.

- c. Topcoat: Epoxy, gloss [, **MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>**.

4. Epoxy, High-Build System [**MPI INT 5.1Y**]:

- a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [, **MPI #101**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- b. Intermediate Coat: High-build epoxy, matching topcoat.

- c. Topcoat: High-build epoxy, low gloss [, **MPI #108**].

- 1) **<Insert manufacturer's name; product name or designation>**.

- d. Topcoat: High-build epoxy, gloss [, **MPI #98**].

- 1) **<Insert manufacturer's name; product name or designation>**.

5. Epoxy Deck Coating System **[MPI INT 5.1LL]**:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, gloss **[, MPI #77]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Epoxy deck coating (slip resistant) **[, MPI #82]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
6. Epoxy-Modified Latex System **[MPI INT 5.1K]**:
 - a. Prime Coat: Primer, rust inhibitive, water based **[, MPI #107]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) **[, MPI #215]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) **[, MPI #115]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
7. Pigmented Polyurethane over Epoxy Primer System **[MPI INT 5.1F]**:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
8. Pigmented Polyurethane over High-Build Epoxy System **[MPI INT 5.1G]**:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal **[, MPI #101]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, high build **[, MPI #108]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) **[, MPI #72]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.
9. Pigmented Polyurethane over Self-Priming Epoxy System **[MPI INT 5.1U]**:
 - a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
 - 1) **<Insert manufacturer's name; product name or designation>**.

- b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
10. Pigmented Polyurethane over Inorganic Zinc and Epoxy System [**MPI INT 5.1H**]:
- a. Prime Coat: Primer, zinc rich, inorganic [**MPI #19**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, gloss [**MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
11. Pigmented Polyurethane over Epoxy Zinc-Rich and Epoxy System [**MPI INT 5.1J**]:
- a. Prime Coat: Primer, zinc rich, epoxy [**MPI #20**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, gloss [**MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [**MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- G. Galvanized-Metal Substrates:
1. Epoxy over Epoxy Primer System [**MPI INT 5.3D**]:
- a. Prime Coat: Primer, epoxy, anti-corrosive, for metal [**MPI #101**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [**MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
2. Epoxy over Vinyl Wash Primer and Epoxy Primer System [**MPI INT 5.3E**]:
- a. Prime Coat: Primer, vinyl wash [**MPI #80**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal [**MPI #101**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - c. Topcoat: Epoxy, gloss [**MPI #77**].

- 1) **<Insert manufacturer's name; product name or designation>.**
- H. Aluminum (Not Anodized or Otherwise Coated) Substrates:
1. Epoxy System **[MPI INT 5.4B]:**
 - a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 2. Pigmented Polyurethane System **[MPI INT 5.4C]:**
 - a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Topcoat: Polyurethane, two-component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
- I. Copper Substrates:
1. Epoxy System **[MPI INT 5.5B]:**
 - a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 2. Pigmented Polyurethane System **[MPI INT 5.5C]:**
 - a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - b. Intermediate Coat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>.**
- J. Stainless-Steel Substrates:
1. Epoxy System **[MPI INT 5.6C]:**

- a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) <Insert manufacturer's name; product name or designation>.
2. Pigmented Polyurethane System [**MPI INT 5.6D**]:
- a. Prime Coat: Primer, vinyl wash [, **MPI #80**].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy, gloss [, **MPI #77**].
 - 1) <Insert manufacturer's name; product name or designation>.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) <Insert manufacturer's name; product name or designation>.
- K. Wood Substrates: Glued-laminated construction.
1. Epoxy System [**MPI INT 6.1L**]:
- a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) <Insert manufacturer's name; product name or designation>.
2. Pigmented Polyurethane System [**MPI INT 6.1E**]:
- a. Prime Coat: Polyurethane, two component, pigmented, matching topcoat.
 - b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) <Insert manufacturer's name; product name or designation>.
- L. Wood Substrates: [Wood trim] [Architectural woodwork] [Doors] [Windows] [and] [wood board paneling].
1. Epoxy System [**MPI INT 6.3L**]:
- a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) <Insert manufacturer's name; product name or designation>.
- M. Fiberglass Substrates:
1. Epoxy System [**MPI INT 6.7D**]:

- a. Prime Coat: Epoxy, matching topcoat.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
2. Pigmented Polyurethane System [**MPI INT 6.7E**]:
 - a. Prime Coat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, matching prime coat.
 - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6) [, **MPI #72**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 3. Epoxy-Modified Latex System [**MPI INT 6.7F**]:
 - a. Block Filler: Block filler, latex, interior/exterior [, **MPI #4**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [, **MPI #215**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [, **MPI #115**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
- N. [**Gypsum Board**] [**Plaster**] Substrates:
1. Epoxy System [**MPI INT 9.2E**]:
 - a. Prime Coat: Primer sealer, latex, interior [, **MPI #50**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss [, **MPI #77**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 2. Epoxy, High-Build System [**MPI INT 9.2N**]:
 - a. Prime Coat: Primer sealer, latex, interior [, **MPI #50**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - b. Intermediate Coat: High-build epoxy, matching topcoat.
 - c. Topcoat: High-build epoxy, low gloss [, **MPI #108**].
 - 1) **<Insert manufacturer's name; product name or designation>**.
 - d. Topcoat: High-build epoxy, gloss [, **MPI #98**].

- 1) <Insert manufacturer's name; product name or designation>.
3. Epoxy-Modified Latex System **[MPI INT 9.2F]**:
 - a. Prime Coat: Primer sealer, latex, interior [, **MPI #50**].
 - 1) <Insert manufacturer's name; product name or designation>.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5) [, **MPI #215**].
 - 1) <Insert manufacturer's name; product name or designation>.
 - d. Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6) [, **MPI #115**].
 - 1) <Insert manufacturer's name; product name or designation>.

END OF SECTION

DIVISION 10

SPECIALTIES

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SECTION 10 11 00
VISUAL DISPLAY UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Visual display board assemblies.
2. Floor-to-ceiling visual display assemblies.
3. Rail support system for visual display board assemblies.
4. Modular support system for visual display board assemblies.
5. Sliding visual display units.
6. Visual display conference units.
7. Glass markerboards.
8. Display rails.
9. Natural-slate chalkboards.

B. Related Requirements:

1. Section 09 77 23 "Fabric-Wrapped Panels" for tackable, fabric-covered panels mounted on walls.
2. Section 10 11 46 "Visual Display Fabrics" for visual display wall coverings intended for use with dry-erase markers.
3. Section 10 12 00 "Display Cases" for [individually framed and enclosed, wall-mounted bulletin boards] [and for] [tackboards within display cases].

1.02 PRE-INSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.03 ACTION SUBMITTALS

A. Product Data:

1. Visual display board assemblies.
2. Floor-to-ceiling visual display assemblies.
3. Rail support system for visual display board assemblies.
4. Modular support system for visual display board assemblies.
5. Sliding visual display units.
6. Visual display conference units.
7. Glass markerboards.
8. Display rails.
9. Natural-slate chalkboards.

- B. Product Data Submittals: For each product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
 - 2. Include electrical characteristics for motorized units.
 - C. Shop Drawings: For visual display units.
 - 1. Include plans, elevations, sections, details, and attachment to other work.
 - 2. Show locations of panel joints. [Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.]
 - 3. Show locations and layout of special-purpose graphics.
 - 4. Include sections of typical trim members.
 - 5. Include wiring diagrams for power and control wiring.
 - D. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:
 - 1. Samples of facings for each visual display panel type, indicating color and texture.
 - 2. Fabric swatches of fabric facings for tackboards.
 - 3. Actual factory-finish color samples, applied to **[aluminum]** **[wood]** substrate.
 - 4. Include accessory Samples to verify color selected.
 - E. Samples for Verification: For each type of visual display unit indicated.
 - 1. Visual Display Panel: Not less than 8-1/2 by 11 inches, with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
 - 2. Trim: 6-inch-long sections of each trim profile.
 - 3. Display Rail: 6-inch-long section of each type.
 - 4. **[Rail]** **[Modular]** Support System: 6-inch-long sections.
 - 5. Accessories: Full-size Sample of each type of accessory.
 - F. Product Schedule: For visual display units. **[Use same designations indicated on Drawings.]**
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Product Test Reports: For each visual display unit, for tests performed by **[manufacturer and witnessed by a qualified testing agency]** **[a qualified testing agency]**.
 - C. Sample Warranties: For manufacturer's special warranties.
- 1.05 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For visual display units **[and motorized units]** to include in maintenance manuals.
- 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical [wall area] [visual display unit] [floor-to-ceiling visual display assembly] <Insert description> as shown on Drawings. Include accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.08 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period:
 - a. **[50]** <Insert number> years from date of Substantial Completion.
 - b. Life of the building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. See current Campus Standards for acceptable Visual Display Units Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **[25]** <Insert value> or less.
 2. Smoke-Developed Index: **[50]** **[450]** <Insert value> or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 2.03 VISUAL DISPLAY BOARD ASSEMBLIES
- A. Visual Display Board Assemblies: <Insert drawing designation>.
- B. Visual Display Board Assembly: **[Field]** **[or]** **[factory]** fabricated.
1. Assembly: **[Chalkboard]** **[markerboard]** **[and]** **[tackboard]**.
 2. Corners: **[Square]** **[Rounded]**.
 3. Width: **[As indicated on Drawings]** <Insert dimension>.
 4. Height: **[As indicated on Drawings]** <Insert dimension>.
 5. Mounting Method: **[Direct to wall]** **[Rail support system]** **[Modular support system]**.
- C. Chalkboard Panel: **[Porcelain-enamel]** **[High-pressure chalkboard laminate]** **[Melamine]** **[Painted-finish]**-faced chalkboard panel on core indicated.
1. Color: **[Green]** **[Blue]** **[Brown]** **[Black]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]** <Insert color>.
- D. Markerboard Panel: **[Porcelain-enamel-faced]** **[High-pressure markerboard laminate-faced]** **[Melamine-faced]** <Insert facing> markerboard panel on core indicated.
1. Color: **[White]** **[Beige]** **[Tan]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]** <Insert color>.
- E. Tackboard Panel: **[Natural-cork]** **[Plastic-impregnated-cork]** **[Vinyl-fabric-faced]** **[Polyester-fabric-faced]** tackboard panel on core indicated.
1. Fabric Wrapped Edge: Wrap edge of tackboard panel with fabric facing.
 2. Color and Pattern: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
- F. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; **[standard size and shape]** **[slim size and standard shape]** **[of size and shape indicated on Drawings]** <Insert size and shape>.
1. Field-Applied Trim: Manufacturer's standard, **[snap-on trim with no visible screws or exposed joints]** **[slip-on trim]** **[screw-on trim with Phillips flat-head screws]**.
 2. Aluminum Finish: **[Clear anodic]** **[Color anodic]** **[Manufacturer's standard baked-enamel or powder-coat]** finish.
 - a. Color: **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]** <Insert color>.

- G. Factory-Applied Wood Trim: **[Red oak] [Walnut] [Manufacturer's standard species]** <Insert species>, not less than 1/2 inch thick; **[standard size and shape] [of size and shape indicated on Drawings]** <Insert size and shape> with **[opaque] [transparent]** finish.
- H. Field-Applied Wood Trim: Comply with requirements specified in **[Section 06 20 23 "Interior Finish Carpentry."]** **[Section 06 40 23 "Interior Architectural Woodwork."]**
- I. Vinyl Trim: **[Dark brown] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]**.
- J. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, **[balanced around center of board, as acceptable to Architect] [as indicated on approved Shop Drawings]**.
- K. Combination Assemblies: Provide **[manufacturer's standard exposed trim] [H-trim] [hidden spline]** between abutting sections of visual display panels.
- L. Chalktray: Manufacturer's standard; continuous.
1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
 2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
- M. Display Rail: Manufacturer's standard, extruded-aluminum display rail with **[plastic-impregnated-cork]** <Insert material> insert, end stops, **[and continuous paper holder,]** designed to hold accessories.
1. Size: **[1 inch] [2 inches] [3 inches]** high by **[full length of visual display unit] [length indicated on Drawings]**.
 2. Map Hooks: **[Two]** <Insert number> map hooks for every **[48 inches]** <Insert dimension> of display rail or fraction thereof.
 3. Map Hooks and Clips: **[Two]** <Insert number> map hooks with flexible metal clips for every **[48 inches]** <Insert dimension> of display rail or fraction thereof.
 4. Flag Holder: **[One]** <Insert number> for each room.
 5. Tackboard Insert Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]** <Insert color>.
 6. Aluminum Color: Match finish of visual display assembly trim.
- N. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.
- O. Special-Purpose Graphics: Fuse or paint **[semivisible writing guidelines] [penmanship lines] [music staff lines] [grid, 1 inch square] [rectangular graph coordinates] [polar graph coordinates] [horizontal lines, 2 inches o.c.] [USA map] [world map] [soccer field] [football field] [basketball court]** <Insert description of special-purpose graphics> graphic onto surface of visual display unit **[, in locations indicated]**.
- 2.04 FLOOR-TO-CEILING VISUAL DISPLAY ASSEMBLIES
- A. Floor-to-Ceiling Markerboard Panel Assemblies: Consisting of markerboard panels with **[porcelain-enamel] [high-pressure markerboard laminate]** facing on core indicated; fabricated for floor-to-ceiling assemblies.

1. Color: [White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors] <Insert color>.
- B. Floor-to-Ceiling Tackboard Panel Assemblies: Consisting of tackboard panels with **[natural-cork]** **[plastic-impregnated-cork]** **[vinyl-fabric]** **[polyester-fabric]** facing on core indicated; fabricated for floor-to-ceiling assemblies.
1. Edge Treatments:
 - a. Panel-Joint Edges: **[Wrapped with fabric]** **[Concealed by fabric-covered trim]**.
 - b. Top-of-Wall Edges: **[Wrapped with fabric]** **[Concealed by fabric-covered trim]**.
 - c. Bottom-of-Wall Edges: **[Wrapped with fabric]** **[Concealed by fabric-covered trim]**.
 - d. Corners: **[Wrapped with fabric]** **[Concealed by fabric-covered trim]**.
 2. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors] <Insert color>.
- C. Width: **[Full width of wall]** **[As indicated on Drawings]** <Insert dimension>.
- D. Height: **[Full height of wall]** **[Full height of wall above base]** **[As indicated on Drawings]** <Insert dimension>.
- E. Joint Accessories: Manufacturer's standard, **[exposed color-matched trim]** **[fabric-covered trim]** **[concealed aluminum or steel spline]** at butt joints.
- 2.05 RAIL SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES
- A. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards **;** **and capable of gripping and suspending paper directly from rail**.
1. Finish: [Clear anodic] [Color anodic] [Manufacturer's standard baked enamel or powder coat].
 2. Color and Gloss: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- B. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display board assemblies by engaging support rail and top trim of board.
- C. Visual Display Board Assemblies: Fabricated from not less than 3/8-inch-thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.
- 2.06 MODULAR SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES
- A. Standards: 72-inch-long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Space slots at not less than **[4 inches]** <Insert dimension> o.c.
1. Finish: [Clear anodic] [Color anodic] [Manufacturer's standard baked enamel or powder coat].

2. Color and Gloss: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

B. Panel Clips: Extruded aluminum or steel with finish to match standards.

2.07 SLIDING VISUAL DISPLAY UNITS

A. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, aluminum-framed horizontal-sliding visual display panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

1. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
2. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than **[one-third]** **[one-half]** of overall length of unit.
3. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.
 - a. Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display panel on both faces of each door.
4. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
5. Overall Width: [As indicated on Drawings] <Insert dimension>.
6. Overall Height: [As indicated on Drawings] <Insert dimension>.

B. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, and aluminum-framed vertical-sliding panels; **[motor operated;]** designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

1. Type: Tubular frame on **[four sides]** **[top and two sides, with sides extending to floor; with kick panel to conceal sliding panels]**. Design unit to support panels independently of wall.
2. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
3. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
4. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.

5. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.
6. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.
 - a. Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, **[110]** **[220]** V, 60 Hz.
 - b. Control Station: Three-position, **[maintained]** **[momentary]** contact, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide **[one]** **<Insert number>** control station(s) for each sliding panel unit.
 - c. Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.
7. Overall Width: **[As indicated on Drawings]** **<Insert dimension>**.
8. Overall Height: **[As indicated on Drawings]** **<Insert dimension>**.

C. Panels and Accessories:

1. Sliding Chalkboard Panel: **[Porcelain-enamel]** **[High-pressure chalkboard laminate]**-faced chalkboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than **[3/8 inch]** **<Insert dimension>** thick.
 - a. Color: **[Green]** **[Blue]** **[Brown]** **[Black]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]** **<Insert color>**.
2. Sliding Markerboard Panel: **[Porcelain-enamel]** **[High-pressure markerboard laminate]**-faced markerboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than **[3/8 inch]** **<Insert dimension>** thick.
 - a. Color: **[White]** **[Beige]** **[Tan]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]** **<Insert color>**.
3. Sliding Tackboard Panel: **[Natural-cork]** **[Plastic-impregnated-cork]** **[Vinyl-fabric-faced]** **[Polyester-fabric-faced]** tackboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than **[3/8 inch]** **<Insert dimension>** thick.
 - a. Color and Pattern: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
4. Fixed Rear Chalkboard Panel: **[Porcelain-enamel]** **[High-pressure chalkboard laminate]**-faced chalkboard panel on core indicated.
 - a. Color: **[Green]** **[Blue]** **[Brown]** **[Black]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]** **<Insert color>**.

5. Fixed Rear Markerboard Panel: **[Porcelain-enamel] [High-pressure markerboard laminate]**-faced markerboard panel on core indicated.
 - a. Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]** <Insert color>.
6. Fixed Rear Tackboard Panel: **[Natural-cork] [Plastic-impregnated-cork] [Vinyl-fabric-faced] [Polyester-fabric-faced]** tackboard panel on core indicated.
 - a. Color and Pattern: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]**.
7. Kick Panel: Manufacturer's standard **[fabric-covered cork] [low-pressure laminate]**.
 - a. Color and Pattern: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]**.
8. Accessories: **[Chalktray] [locks] [and] [easel pad clamps]**.
9. Display Rail: Manufacturer's standard, extruded-aluminum display rail with **[plastic-impregnated-cork]** <Insert material> insert, end stops, **[and continuous paper holder,]** designed to hold accessories.
 - a. Size: **[1 inch] [2 inches] [3 inches]** high by full length of visual display unit.
 - b. Map Hooks: **[Two]** <Insert number> map hooks for every **[48 inches]** <Insert dimension> of display rail or fraction thereof.
 - c. Flag Holder: **[One]** <Insert number> for each sliding visual display unit.
 - d. Tackboard Insert Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]** <Insert color>.
10. Aluminum Trim: **[Factory applied] [Field applied]**; in **[manufacturer's standard]** <Insert description> size and profile; with **[clear anodic]** <Insert description> finish.

2.08 VISUAL DISPLAY CONFERENCE UNITS

- A. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than 3-inch interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display units.
 1. Wood Cabinets: Fabricated from solid wood with integral, solid-wood marker tray. Fabricate hinged door panels with solid-wood frame and wood-veneer exterior surface.
 - a. Species and Finish: **[Red oak] [Walnut] [Mahogany]** <Insert species> with **[natural lacquered] [oiled] [stained]** finish.
 2. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard wood panels finished with high-pressure decorative laminate; with integral marker tray.
 - a. Color: **[Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors]** <Insert color>.

3. Cabinet Corners: **[Square] [Rounded]**.
4. Hardware: Manufacturer's standard, full-height continuous hinges **[, wire door pulls,]** and door bumpers.
5. Fixed Rear Panel: Manufacturer's standard **[porcelain-enamel] [high-pressure markerboard laminate] [glass]** markerboard panel.
 - a. Color: **[White] [Beige] [Tan] [Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors]** <Insert color>.
6. Inside Surface of Doors:
 - a. Same as fixed rear panel.
 - b. Tackboard panel consisting of **[natural-cork] [plastic-impregnated-cork] [vinyl-fabric] [polyester-fabric]** facing on manufacturer's standard core.
 - c. Color: **[Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors]** <Insert color>.
7. Projection Screen: Manufacturer's standard, pull-down, matte, white projection screen, not less than 8 inches smaller in each direction than overall cabinet size, and mounted above rear visual display panel.
8. Fluorescent Light: Manufacturer's standard, not less than 24 inches long, and mounted above rear visual display panel.
9. Width: **[48 inches]** [As indicated on Drawings] <Insert dimension>.
10. Height: **[36 inches] [48 inches] [72 inches]** [As indicated on Drawings] <Insert dimension>.
11. Accessories: **[Cylinder lock] [and] [flip-chart pad clamp]**.

2.09 GLASS MARKERBOARDS

- A. Glass Markerboards: Fabricated of **[6-mm tempered] [or] [6-mm tempered-laminated] [low-iron] [ultra-thin]** glass with steel backing for use with magnets.
 1. Edge Treatment: Smooth polished edge with **[rounded] [eased]** corners.
 2. Frame: Aluminum trim in profile indicated.
 3. Surface: **[Glossy] [Matte]**.
 4. Color: White
- B. Mounting:
 1. Round, stainless steel standoffs, holding glass approximately **[1 inch]** <Insert dimension> from wall surface; mounted **[through holes in] [in notches in standoffs at top and bottom edges of]** markerboard.
 2. Concealed, Z-shaped brackets.
 3. Manufacturer's standard adhesive or adhesive-foam tape mounting.
- C. Graphics: Provide screen-printed graphics as indicated.
- D. Marker Tray: **[Glass] [Aluminum]**, attached with **[stainless steel clips] [magnet]**.

- E. Size: **[18 by 24 inches] [24 by 36 inches] [36 by 48 inches] [48 by 96 inches]** <Insert dimensions>.

2.10 DISPLAY RAILS

- A. Aluminum Display Rail: Manufacturer's standard, extruded-aluminum display rail with **[plastic-impregnated-cork]** <Insert material> tackable insert, **[and continuous paper holder,]** designed to hold accessories.
- B. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.
 - 1. Aluminum Finish: **[Clear anodic]** <Insert description> finish.
- C. Wood Display Rail: Manufacturer's standard wood display rail with **[plastic-impregnated-cork]** <Insert material> insert.
 - 1. Finish: **[Natural oak]** <Insert finish>.
- D. Tackable Insert Color: **[Tan] [Gray] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]** <Insert color>.
- E. Size: **[1 inch] [2 inches] [3 inches]** high by length indicated on Drawings.
- F. End Stops: **[Aluminum] [Not required]**.
- G. Accessories:
 - 1. **[Metal] [Plastic] Map Hooks:** Include **[two]** <Insert number> map hooks per **[room] [20 feet]** <Insert dimension> [of installed display rail].
 - 2. **Roller Brackets:** Include **[two]** <Insert number> roller brackets per **[room] [20 feet]** <Insert dimension> [of installed display rail].
 - 3. **Flag Holders:** Include **[one]** <Insert number> flag holder per **[room] [20 feet]** <Insert dimension> [of installed display rail].

2.11 NATURAL-SLATE CHALKBOARDS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1. <Insert, in separate subparagraphs, manufacturer's name>.
- B. Natural Slate: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.
 - 1. Thickness: Not less than 1/4 inch or more than 3/8 inch thick with maximum deviation of 1/16 inch when an average thickness of at least 1/4 inch is maintained.
- C. Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.
 - 1. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.

2. Provide writing surface free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and free of surface-applied stain, dye, or other artificial coloring.
 3. Length: Furnish panels approximately equal in length with permissible variation not more than 3 inches in either direction of equal spacing. Allow 1/4-inch clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:
 - a. Up to 5 feet; one panel.
 - b. More than 5 feet but less than 9 feet; two panels.
 - c. More than 9 feet but less than 13.5 feet; three panels.
 - d. More than 13.5 feet but less than 18 feet; four panels.
 - e. More than 18 feet but less than 22.5 feet; five panels.
 - f. More than 22.5 feet but less than 27 feet; six panels.
- D. Aluminum: Fabricated from not less than 0.062-inch-thick, extruded aluminum; **[of size and shape indicated on Drawings] <Insert size and shape>; [snap-on type with no visible screws or exposed joints] [screw-on type with Phillips flat-head screws].**
- E. Wood Trim: Comply with requirements specified in **[Section 06 20 23 "Interior Finish Carpentry."]** **[Section 06 40 23 "Interior Architectural Woodwork."]**

2.12 CHALKBOARD PANELS

- A. Porcelain-Enamel Chalkboard Panels: High-pressure factory-laminated chalkboard panels of balanced three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with matte finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
1. Face Sheet Thickness: **[0.021 inch] [0.013 inch]** uncoated base metal thickness.
 2. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
 3. Hardboard Core: 1/4 inch thick; with **[0.005-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.0129-inch-thick, galvanized-steel sheet]** backing.
 4. Particleboard Core: 3/8 inch thick; with **[0.005-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.0129-inch-thick, galvanized-steel sheet]** backing.
 5. Fiberboard Core: **[3/8 inch] [1/2 inch]** thick; with **[0.001-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.0129-inch-thick, galvanized-steel sheet]** backing.
 6. MDF Core: 7/16 inch thick; with manufacturer's standard moisture-barrier backing.
 7. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
- B. High-Pressure Chalkboard Laminate Panels: Factory-laminated chalkboard panels of balanced three-ply construction, consisting of backing, fiberboard core material, and high-pressure chalkboard laminate writing surface.
- C. Melamine Chalkboard Panels: Fabricated from 1/4-inch-thick, sealed and primed hardboard core permanently bonded with thermally fused, melamine-impregnated decorative paper writing surface complying.

- D. Painted-Finish Chalkboard Panels: Fabricated from **[two plies of]** 1/4-inch-thick, treated, tempered hardboard core permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.

2.13 MARKERBOARD PANELS

- A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with **[high] [low]**-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
1. Face Sheet Thickness: **[0.021 inch] [0.013 inch]** uncoated base metal thickness.
 2. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
 3. Hardboard Core: 1/4 inch thick; with **[0.005-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.013-inch-thick, galvanized-steel sheet]** backing.
 4. Particleboard Core: **[3/8 inch] [1/2 inch]** thick; with **[0.005-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.013-inch-thick, galvanized-steel sheet]** backing.
 5. Fiberboard Core: **[3/8 inch] [1/2 inch]** thick; with **[0.001-inch-thick, aluminum foil] [0.015-inch-thick, aluminum sheet] [0.013-inch-thick, galvanized-steel sheet]** backing.
 6. MDF Core: 7/16 inch thick; with manufacturer's standard moisture-barrier backing.
 7. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
- B. High-Pressure Markerboard Laminate Panels: Factory-laminated markerboard panel of three-ply construction, consisting of backing, fiberboard core material, and high-pressure markerboard laminate writing surface.
- C. Melamine Markerboard Panels: Fabricated from 1/4-inch-thick, sealed and primed hardboard panels permanently bonded with thermally fused, melamine-impregnated decorative paper writing surface.

2.14 TACKBOARD PANELS

- A. Tackboard Panels:
1. Facing:
 - a. **[1/16-inch-thick,] [1/8-inch-thick,] [1/4-inch-thick,] [natural cork] [plastic-impregnated cork].**
 - b. **[Vinyl] [Polyester]** fabric.
 - c. **[Vinyl] [Polyester]** fabric factory laminated to **[1/16-inch-] [1/8-inch-] [1/4-inch-]** thick, cork sheet.
 - d. Recycled rubber, 0.44 inch thick; with **[tan] [red] [green] [grey] [blue]** color flecks.
 2. Core:
 - a. Manufacturer's standard.
 - b. **[3/8-inch-] [7/16-inch-]** thick fiberboard.
 - c. 1/4-inch-thick **[hardboard] [or] [particleboard].**

2.15 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. High-Pressure Decorative Laminate: ISO 4586-3.
- C. High-Pressure Markerboard Laminate: Complying with physical testing requirements of ISO 4586-3.
- D. High-Pressure Chalkboard Laminate: Complying with physical testing requirements of ISO 4586-3.
- E. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish **[; with surface-burning characteristics indicated]**.
- F. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout **[; with surface-burning characteristics indicated]**.
- G. Vinyl Fabric: Mildew resistant, washable, complying with ASTM F793/F793M, Type II, **[burlap weave]** **<Insert texture or pattern>**; weighing not less than 13 oz./sq. yd.; with surface-burning characteristics indicated.
- H. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd. (508 g/sq. m); with surface-burning characteristics indicated.
- I. Hardboard: ANSI A135.4, tempered.
- J. Particleboard: ANSI A208.1, Grade M-1.
- K. MDF: ANSI A208.2, Grade 130.
- L. Fiberboard: ASTM C208 cellulosic fiber insulating board.
- M. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- N. Extruded Aluminum: ASTM B221, Alloy 6063.
- O. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
- P. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in **[Section 09 91 23 "Interior Painting"]** **<Insert Section number and title>** and recommended in writing by visual display unit manufacturer for intended substrate.

2.16 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.17 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive **[visual display units] [direct-applied, floor-to-ceiling visual display assemblies]** and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.03 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, **[balanced around center of board, as acceptable to Architect] [as indicated on approved Shop Drawings]**.
 2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
- C. Factory-Fabricated Visual Display Board Assemblies:
1. Adhere to wall surfaces with **[egg-size] <Insert coverage>** adhesive gobs at 16 inches o.c., horizontally and vertically.
 2. Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches o.c. Secure tops and bottoms of boards to walls.
- D. Natural-Slate Chalkboards: Align and level joints between adjoining panels, and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.
- E. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.
1. Mounting Height **[for Grades K through 3] <Insert description>**: **[24 inches] <Insert dimension>** above finished floor to top of chalktray.
 2. Mounting Height **[for Grades 4 through 6] <Insert description>**: **[28 inches] <Insert dimension>** above finished floor to top of chalktray.
 3. Mounting Height **[for Grades 7 and Higher] <Insert description>**: **[36 inches] <Insert dimension>** above finished floor to top of chalktray.
- F. Display Rails: Install rails at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches o.c.
1. Mounting Height: **[48 inches] [60 inches] [72 inches] <Insert dimension>** above finished floor to top of rail.
- G. Floor-to-Ceiling Markerboard Panels: Attach panels to wall surface with **[egg-size] <Insert coverage>** adhesive gobs at 16 inches o.c., horizontally and vertically.
1. Join adjacent panels with concealed steel splines for smooth alignment.
 2. Join adjacent panels with exposed, H-shaped aluminum trim painted to match wall panel.
- H. Floor-to-Ceiling Tackboard Panels: Attach panels to wall surface with **[egg-size] <Insert coverage>** adhesive gobs at 16 inches o.c., horizontally and vertically.
1. Install wrapped-edge panels with butt joints between adjacent wall panels.

2. Join adjacent panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.
- I. Rail Support System: Install horizontal support rail at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall with fasteners at 12 inches o.c.
 1. Mounting Height: **[72 inches]** <Insert dimension> above finished floor to top of rail.
 2. Hang visual display units on rail support system.
 - J. Modular Support System: Install adjustable standards at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at 48 inches o.c., vertically aligned and plumb, and attached to wall with fasteners at 12 inches o.c.
 1. Mounting Height: **[12 inches]** <Insert dimension> above finished floor to bottom of standard.
 2. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
 3. Provide locking screw at top corner of visual display board at each standard.
 4. Hang visual display units on modular support system.
 - K. Sliding Visual Display Units: Install units at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches o.c.
 1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
 - L. Visual Display Conference Units: Install units at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with **[fasteners through back of cabinet] [concealed brackets screwed to wall] [concealed wood cleats screwed to wall]**.
 1. Mounting Height: **[72 inches]** <Insert dimension> above finished floor to top of cabinet.
- 3.04 CLEANING AND PROTECTION
- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
 - B. Touch up factory-applied finishes to restore damaged or soiled areas.
 - C. Cover and protect visual display units after installation and cleaning.
- 3.05 DEMONSTRATION
- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain motorized, sliding visual display units.

END OF SECTION

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SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY OF WORK INCLUDED

- A. CONTRACTOR shall be responsible for securing all sign permits, including payment of fees, required by City & County of Los Angeles and all other agencies. for the installation of all exterior and interior signage for the Project.
- B. Sign Fabrication: Types of signs, messages, and graphics are indicated on the drawings and herein, and require various materials, finishes, illumination and fabrication and installation techniques.
- C. Shop drawings, layouts, samples, and mock-ups for LACCD approval.
- D. Installation of all fabricated signs, including all fasteners and fastenings and related electrical and data connections.
- E. Coordination with all trades of this Contract required for the fabrication and installation of the signage, including the approvals by the LACCD required in this Section. Fabrication and installation of the Work in accordance with National Electrical Code (NEC); latest edition, Underwriters Laboratory UL); latest edition, National Fire Protection Agency (NFPA); latest edition and National Electrical Manufacturers Association Standards,
- F. Coordination and verification of all messages with LACCD. LACCD to provide complete set of sign location plans with sample numbering system and electronic message schedule template for fabricator to complete sign message schedule for submission and approval by the LACCD.
- G. Verification of all conditions and sign dimensions in the field. Sign Fabricator to coordinate all signage requirements with the architectural, structural, lighting, electrical, and telecommunications drawings to ensure that all proposed signs can be installed, with power and required data connections and structurally supported. Verification of conditions and sign dimensions to be completed prior to sign fabrication and approval of all required submittals.
- H. Sign Types and Quantities
- I. The Sign Fabricator is responsible for verifying quantities with the LACCD and DESIGNER.

1.02 DESIGN CRITERIA

- A. SHOP DRAWINGS
- B. The Drawings presented for pricing are not fabrication drawings. The Signage Contractor is expected to provide all details necessary to effectively explain and specify the fabrication process and the expected performance of the installed product. The Signage Contractor must demonstrate through details and specifications their complete understanding of the desired final product and the method/process by which they are producing said product. The Signage Contractor is responsible to field measure prior to submitting Shop Drawings. Repackaging the supplied Drawings with new title blocks and delivering them as submittals will not be accepted. Although art may be supplied electronically, Signage Contractors must be prepared to create all graphic content from scratch – per instance as requested - to demonstrate and verify the quality and accuracy of the delivered product.

- C. The Architectural Graphics Drawings represent the design intent for the signs required for the Project. The Sign Fabricator is responsible for the proper engineering of all elements of the Work and where applicable. The internal structure, dimensions, and specifications for all items shall be indicated in the shop drawings.
- D. Provide shop drawings for all items including, but not limited to the following:
 - 1. Complete fabrication and installation drawings for each sign type. Indicate dimensions, materials, finishes, fastening, anchorage, joining, sealing, backing, utility requirements, rough-in, and adjacent related site conditions.
 - 2. Each sign type with all graphic elements.
 - 3. Evacuation Map final graphics. The project signage design intent documentation will provide a template to be used for developing specific area plans and routes as coordinated with the LACCD representative and Emergency Egress plans.
 - 4. All letter styles shall be accurately reproduced.
 - 5. Connections and routing for all power and data cabling.
 - 6. Braille message coordinated with corresponding raised characters.

1.03 SUBMITTALS

- A. Procedure: Prepare submittals in accordance with any LACCD Design Guideline requirements and to include the following:
 - 1. Notes on Drawings shall clearly define any actions requiring review by the LACCD.
 - 2. First article of production-run items, both large and small, will be reviewed by the LACCD before production run is commenced.
 - 3. It shall be the responsibility of the Contractor to schedule all review meetings with the LACCD.
- B. Submit physical samples of sufficient size and quantity to illustrate materials, finishes, equipment, or workmanship, and to establish standards by which completed work will be judged. Samples must represent the functional characteristics of the product or material, with integrally related parts and attachment devices, colors, and finishes.
- C. All samples to have a place for stamp approval.
- D. Required samples for review:
 - 1. Full 6" x 6" set of all specified paint colors and finishes.
 - 2. Complete, scaled, message layout for each sign face, to demonstrate proper spacing and content (black text on white background: outline not accepted).
 - 3. Sample of each type of fastener to be used.
 - 4. Each type of exposed metal used for major elements of work with respective finish.
 - 5. Each type of adhesive vinyl film, including computer-cut designs, shown full-size on each of the specified ground colors.
 - 6. Mock-ups as scheduled in this section. Mock-ups shall become the property of LACCD and are not to be part of the completed work.
 - 7. Unless otherwise noted, one full size, complete, item must be prepared and installed by the fabricator as "first article" for each sign type. Upon inspection and approval by the LACCD, the fabrication of subsequent articles may continue.
 - 8. Other items as may be required by LACCD, or as noted on the Drawings or herein.

- E. Extra Materials / Spares: Deliver to the appropriate LACCD's Representative contact person, in manufacturer's original packaging and store at the Project where directed.
 - 1. Furnish (1) gallon of each finish paint color for touch-up purposes.
 - 2. Furnish (6) lamps of each type and size used in the signage (as applicable).
 - 3. Furnish spare keys to master keyed locks on directory or Kiosk signage.
- F. Supplementary Product Literature: Submit for information. Furnish within seven (7) days of request, manufacturer's literature describing the general properties of each product to be used in the work.

1.04 PERMITS BY SIGNAGE CONTRACTOR

- A. Signage Contractor shall make all submittals for each permit via the LACCD's Representative. Signage Contractor shall be responsible for paying all fees, making adjustments as required, or any task necessary for obtaining local building and installation Sign permits for the proper execution of the Work.

1.05 QUALITY ASSURANCE

- A. Mock-ups and Prototypes:
 - 1. Provide a mock-up of each sign type on-site for review.
 - 2. Utilize the same materials and installation methods in the mock-up as intended for the final Work. Schedule the installation so that the mock-up may be examined, and any necessary adjustments made, prior to commencing fabrication of the final Work. Replace unsatisfactory items as directed.
 - 3. When accepted, mock-up shall serve as the standard for materials, workmanship, and appearance for the Work throughout the project.
- B. Work-In-Progress Approvals:
 - 1. Provide work-in-progress sign elements reviews. Scheduled or unscheduled viewings at the Fabrication Facility may be initiated by the LACCD's Representative as deemed necessary to ensure continued quality control and make any adjustments required during fabrication. Unsatisfactory items are to be corrected by the Signage Contractor as directed by the LACCD.
- C. Regulatory Requirements:
 - 1. Comply with applicable requirements of the Applicable Laws and Authorities. Obtain necessary approvals and permits from all such Authorities as required.
- D. Markings and Labels:
 - 1. Locate markings, labels, manufacturer names and other identifications so as to be concealed from public view and as acceptable by the LACCD's Representative.
 - 2. No trade name or other identification shall appear on any item where it will be seen by the public, except as specifically approved by the LACCD's Representative in advance.
- E. Final Location of Signs:
 - 1. The location of signs as shown on the Location Plans is for general reference only and in some cases is not representative of the exact final location. Final locations of Signs shall be field located in coordination with the LACCD's Representative.
 - 2. Signage Contractor shall arrange for meetings at the Project to accommodate direction of final locations according to Project Construction Schedule.

F. Lettering:

1. The Signage Contractor shall be responsible for the quality control of all lettering. All letterforms shall be crisp, sharp yet edges must not be abrasive, free of nicks, ragged edges, and discontinuous curves. All lettering shall conform to approved typeface, weight and letter spacing. No substitutions of typeface foundry, brand or version or implementation technique will be accepted without prior approval.
2. Vinyl Die Cut Graphics: All camera-ready artwork shall be anagraph scanned for cutting on a Gerber Sign Maker II or approved equal.
3. All cutting and routing shall be executed in such a manner that all edges and corners of finished letterforms are true and clean. Letterforms with rounded positive or negative corners, nicked, cut, or ragged edges, etc., will not be accepted. All letterforms shall be so aligned as to maintain a baseline parallel to the sign format. Margins must be maintained as specified in drawings.
4. All Work under the Agreement shall be performed by skilled craftsmen under supervision of trained foremen, experienced in the trade of craft required to accomplish the Work and produce a product of high quality.
5. Character spacings in words must be kerned.

G. Tactile sign messages:

1. All tactile sign messages must comply with CBC/LABC Sections 11B-703.2 through 11B-703.4
2. Character spacing shall be measured between the two closest points of adjacent raised characters within a message, excluding word spaces. Where characters have rectangular cross sections, spacing between individual raised characters shall be 1/8-inch (3.2 mm) minimum and 4 times the raised character stroke width maximum. Where characters have other cross sections, spacing between individual raised characters shall be 1/16 inch (1.6 mm) minimum and 4 times the raised character stroke width maximum at the base of the cross sections, and 1/8 inch (3.2 mm) minimum and 4 times the raised character stroke width maximum at the top of the cross sections. Characters shall be separated from raised borders and decorative elements 3/8-inch (9.5 mm) minimum.
3. Braille shall be contracted Braille (Grade 2), domed compliant with CBC/LABC Table 11B-703.3.1, and maintain a minimum 3/8 inch clear-space from other tactile elements.
4. Proof-reading of Braille messages is to be performed by the sign fabricator prior to fabrication.

H. High quality of workmanship:

1. The Signage Contractor shall be responsible for the high quality of all materials and workmanship required for the execution of the Agreement including materials and workmanship of any firm or individual who act as Signage Contractor's Sub-Contractor.
2. Signage Contractor shall be responsible for providing up-to-date drawings, specifications, graphic schedule, etc., to all sub-contractors.

I. Dimensions:

1. Written dimensions on drawings shall have precedence over scaled dimensions.
2. Signage Contractor shall verify and be responsible for all dimensions and conditions shown by these drawings. Shop details must be approved by the LACCD's Representative prior to fabrication.

J. Discrepancies

1. Signage Contractor shall notify the LACCD's Representative of any discrepancies in the Drawings, Sign Location Plan or Sign Message Schedule, in field dimensions or conditions and/or changes required in construction details.

K. Regulatory Requirements:

1. Comply with applicable portions in 2010 ADA Standards, current version of CBC, and current version of LABC.
2. References
 - a. California Building Code – California Fire Code – Title 24
 - b. California Public Safety Codes – Title 19
 - c. California Environmental Protection – Title 27
 - d. National Association of Architectural Metal Manufacturers (NAAMM) “Metal Finishes Manual.”
 - e. American Welding Society (AWS) – AWS D1.1 “Structural Welding Code, Steel,” and AWS D1.2 “Structural Welding Code, Aluminum.”
 - f. Underwriters Laboratories Inc. (UL) – Standards for Safety, UL Publication 48 “Electric Signs.”

1.06 GRAPHICS/ARTWORK

- A. LACCD to provide artwork via electronic file transfer; Adobe Illustrator, Acrobat PDF, MAC Format for graphic layouts included in the Drawings.

1.07 WARRANTY

A. Signage Warranty

1. Submit to the LACCD's Representative a 5-year written warranty (effective the date of final acceptance) covering all Signs, notarized by the Signage Contractor and Installer (if Sub-Contractor is used), agreeing to repair or replace the Defective Signs. Upon notification of such Defective Signs within the warranty period, make necessary repairs or replacement at the convenience of the LACCD's Representative.

B. Linear Polyurethane Paint Factory Finish Warranty

1. Submit to the LACCD's Representative a 5-year written warranty, warranting that the factory-applied linear polyurethane finishes will not develop excessive fading or excessive non uniformity of color or shade, and will not crack, peel, pit, corrode or otherwise fail as a result of Defects in materials or workmanship within the following defined limits. Upon notification of such Defects within the Warranty Period, make necessary repairs or replacement at the convenience of the LACCD's Representative.

C. “Excessive Fading”

1. A change in appearance that is perceptible and objectionable as determined when visually compared with the original color range standards.

D. “Excessive Non-Uniformity”

1. Non-uniform fading to the extent that adjacent panels have a color difference greater than the original acceptable range of color.

E. “Will Not Pit or Otherwise Corrode”

1. No pitting or other type of corrosion, discernible from a distance of 10' (3 m), resulting from the natural elements in the atmosphere at the project site.

1.08 MAINTENANCE

A. Maintenance and Operating Manuals

1. Submit four (4) copies of the Maintenance and Operating Manuals to the LACCD's Representative and 1 copy to the Executive Architect.
2. Furnish complete manuals describing the materials, devices, and procedures to be followed in operating, cleaning, and maintaining the Work. Include manufacturers' brochures and parts lists describing the actual materials used in the Work, including metal alloys, finishes, electrical components, and other major components.
3. Assemble manuals for component parts into single binders identified for each system.

B. Instruction

1. Prior to acceptance, establish with LACCD's Representative an instruction and training program for LACCD's Representative's personnel.
2. Notify the LACCD's Representative in writing at least 7 days prior to commencement of the program providing an outline of topics indexed to the Maintenance and Operating Manual.
3. Provide a trained instructor. Provide three (3) consecutive 4-hour periods of training scheduled during the normal 8-hour working day. Instruction and training shall include, but shall not be limited to, procedures to be followed in the normal day-to-day maintenance and operation of the Work.

PART 2 PRODUCTS

2.01 FABRICATION

- A. Signage shall be complete for proper installation as described in the Drawings.
- B. Finish work shall be firm, well anchored, in true alignment, properly squared, with smooth clean uniform appearance, without holes, cracks, discoloration, distortion, stains, or marks.
- C. Construct all work to eliminate burrs, dents, cutting edges, and sharp corners.
- D. Finish welds on exposed surfaces to be imperceptible in the finished work.
- E. Except as indicated or directed otherwise, finish all surfaces smoothly.
- F. Surfaces, that are intended to be flat, shall be without dents, bulges, oil canning, gaps, or other physical deformities.
- G. Surfaces, that are intended to be curved, shall be smoothly free-flowing to the required shapes.
- H. Except where approved otherwise by LACCD, conceal all fasteners.
- I. Make access panels tight-fitting, light-proof, and flush with adjacent surfaces.
- J. Conceal all identification labels and Underwriters Limited labels to conform to Underwriters Limited Codes.

- K. Carefully follow the manufacturer's recommended fabricating procedures regarding expansion or contraction, fastening, and restraining of acrylic plastic.
- L. Exercise care to ensure that painted, polished, and plated surfaces are unblemished in the finished work.
- M. Isolate dissimilar materials. Exercise particular care to isolate nonferrous metals from ferrous metals.
- N. All illumination shall be even and without hot spots.
- O. Ease all exposed metal edges.
- P. Provide miscellaneous metal items required for completion of the work even though not shown or specified.
- Q. Refer to Drawings for sign color specifications.
- R. Paint finishes shall be Matthews Acrylic Polyurethane with Matthews Primers and Metal Pre-Treatments or LACCD approved equal.
- S. Shop painting to be uniform on and around all sign elements to ensure sign elements will withstand all weather conditions.
- T. Mounting: Mounting plates shall be in conformance with the manufacturer's written recommendations.

2.02 MATERIALS

- A. All Specified Metals
 - 1. Aluminum
 - a. Aluminum shall be suitable for ornamental, architectural work. The surface finish shall be smooth, and free of extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of the specific application.
 - 2. Stainless Steel
 - a. Stainless steel shall be suitable for ornamental and architectural work. The surface finish shall be smooth, and free of all extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of specific applications. Structural metal for concealed framing shall be of galvanized rolled steel or equal as required to satisfy structural requirements.
- B. Aluminum exterior cabinets, spacers, backplates and frames shall be constructed from 0.25 inch aluminum, #4 horizontal brushed and clear anodized finish, unless otherwise specified on Drawings.
- C. Aluminum interior plaques shall be constructed from 0.125 inch aluminum, #4 horizontal brushed finish with semi-gloss linear polyurethane clear coat, unless otherwise specified on Drawings.
- D. Aluminum interior fabricated components shall be constructed from 0.125 inch thickness aluminum sheet.

- E. Adhesive used for installing Signs shall be manufactured by Dow Corning or equal. "VHB" tape such as Polyfoam or "Isotac" contact adhesive tape manufactured by 3M shall be used in conjunction with silicone adhesives for installation of wall signs, in minimum thicknesses available.
- F. Extruded aluminum shapes utilizing 6063-T6 aluminum alloys, unless otherwise specified on Drawings.
- G. Concrete Installation of anchoring devices into concrete slab shall be adjusted to avoid penetrating existing reinforcing conduit, etc. contained in the concrete slab. Coordinate with the Architect and Structural Engineer.
- H. Stainless steel exterior cabinets, spacers, backplates and frames shall be constructed from 0.125 inch stainless steel, #4 horizontal brushed and clear anodized finish, unless otherwise specified on Drawings.
- I. Stainless steel interior plaques shall be constructed from 0.125 inch thickness stainless steel sheet, #4 horizontal brushed finish with semi-gloss linear polyurethane clear coat, unless otherwise specified on Drawings.
- J. Stainless steel interior fabricated components shall be constructed from 0.0625 inch stainless steel, unless otherwise specified on Drawings.
- K. Stainless steel shall be suitable for ornamental and architectural work. Surface finish shall be smooth, free of all extrusion marks or imperfections. Alloy shall be selected to meet the structural requirements of specific application. Structural metal for concealed framing shall be of galvanized rolled steel or equal as required to satisfy structural requirements.
- L. Acrylic intended for non-illuminated use shall be 0.25 inch cast acrylic sheet with non-glare finish, unless otherwise specified on Drawings. Acrylic intended for edge-illuminated use shall be 10mm extruded acrylic sheet with embedded diffuser particles designed specifically for edge-lighting, unless otherwise specified on Drawings.
- M. Use Plexiglas II as manufactured by Rohm and Haas Co., or equal quality. Thickness shall be as indicated on Drawings or not less than 1/8" thick. Signage Contractor shall provide color and finish samples of all plastics for approval before fabrication; no substitution in color, thickness, or finish of plastics will be accepted without written approval from the LACCD's Representative. All plastics shall be of uniform color, translucence and illumination, as supplied by manufacturer. Any exposed edges of acrylic shall be finished so as no saw marks are visible.
- N. Decal or Transfer: Provide special printed paper or vinyl suitable for reproducing the design onto material indicated, as required. Submit sample to the LACCD's Representative for approval.
- O. Aluminum posts shall be constructed from 2-inch square T52 tubes, 0.1875 wall thickness and #4 brushed and clear anodized finish with capped ends, unless otherwise specified on Drawings.
- P. Hardware / Hinges: Provide and install all incidental hardware necessary for the proper functioning of the Signs, including, but not restricted to, materials and products covered in this section. Provide stainless steel hinges for all hinged access panels. Provide pin tumbler locks for all access panels requiring locks. Provide stainless steel fasteners for assembling ferrous and non-ferrous metals.

- Q. Bolts, nuts, screws, washers, anchors and other devices required to complete the Work. Signage Contractor shall use the same basic metal or alloy as the metal fastened, and finish to match in color and texture. Use stainless steel 300 series alloy where used to join dissimilar materials.
- R. All exposed fasteners to be 0.125 inch flathead stainless steel screws painted to match adjoining surfaces unless otherwise specified on drawings.
- S. Pin-mount supports shall be 3/16" to 1" diameter painted threaded rods as appropriate.
- T. Insulation /Material Isolation: Separate all ferrous and non-ferrous metals with non-conductive gaskets to prevent electrolysis. In addition to gaskets, provide stainless steel fasteners for some cases as required.
- U. Welding Electrodes and Filler Metal
 - 1. Provide the alloy and type of welding electrodes and filler metal required for strength, workability, compatibility and color match after grinding smooth and finishing the fabricated product.
- V. Applied interior vinyl graphics to be High Performance Cast Vinyl Sheeting, unless otherwise specified on Drawings. Applied exterior vinyl graphics to be High Performance Reflective Vinyl Sheeting, unless otherwise specified on Drawings.
- W. Additional Material/Processes: For materials or processes described in the preceding list, the material and/or process as detailed in the design documents shall be used as the meet or exceed equivalent.

2.03 ELECTRICAL COMPONENTS

- A. Electrical components must conform to applicable electrical codes and the following:
 - 1. All materials must be approved and listed by Underwriters Laboratories, Inc.
 - 2. Light Emitting Diode (LED) general lighting requirements:
 - a. Provide sufficient LED wattage, quantities and spacing to ensure continuous, maximum illumination.
 - b. Provide LED lighting prototypes to verify brightness and uniformity of lighting with designer.
 - 3. LED lighting component, color, and power requirements:
 - a. Edge lighting – fabricated linear white LED's 24 VAC
 - b. Back lighting – fabricated matrix white LED's 24 VAC
 - 4. Heavy duty, non-keyed, flush mounted, fused, or un-fused disconnects. Provide NEMA 1 for dry locations and proper enclosure for others.
- B. Electrical Wiring and Equipment: Provide and install electrical materials such as ballasts, transformers, lamps, sockets, neon units, connectors, and all other equipment which shall be new and shall be approved by Underwriters Laboratories, Inc. The assembly of all components within the illuminated signs shall conform to all standards of Underwriters Laboratories, Inc. as published in the latest edition of "Standards for Sign Safety" and all illuminated signs shall bear the U.L. label. All wiring and equipment shall be concealed within the Sign structure.
- C. Conduit and Devices: Provide rigid steel conduit, junction boxes and associated devices in accordance with applicable codes as required.

- D. Wiring: Minimum #12 AWG copper shall be used. High tension wiring shall not be less than GTO 15 wire as manufactured by Carol Cable Company or approved equal. All wiring shall be AWM 90 0 centigrade 1000 volt TW/MTW U.L. file no. 18971. Wiring connectors for wire splicing shall be U.L. approved 1000 volt capacity and shall be Scotch Lock type Y or R or equal. All splices should be easily accessible for inspection and should be shown on Shop Drawings.
- E. Disconnect Switch: All Signs or Sign components with electrical service shall be equipped with an approved external disconnect switch, flush mounted on the cabinet / Sign, with circuits and capacity to control all primary wiring within the Sign. Location of switch must be shown on Shop Drawings and is subject to approval.
- F. Illumination: All signs with LED fixtures shall provide even, diffused, illumination without light leaks or hotspots. Signage Contractor shall provide any specification information required to verify performance. All fixtures shall be provided by the Signage Contractor. Signage Contractor shall provide waterproof flush access panel(s), which shall be concealed wherever possible. Conduit wiring and electrical equipment from the field electrical connection to any part of the sign and within the sign shall be provided by the Signage Contractor.
- G. Ventilation: While maintaining a proper weather seal, Signage Contractor shall provide for sufficient ventilation of Sign components to prevent overheating or warping; allowing for color of sign, mounting surface, climate conditions, etc. In providing for ventilation, Signage Contractor shall protect sign from elements (rain, wind, debris, etc.) that might cause operational or cleaning problems. Signs / cabinets with light leaks will not be accepted. Signage Contractor shall utilize stainless steel bug mesh screen for integration with weep holes or vent / louvers on the Signs to prevent insect migration into illuminated Signs.

2.04 FINISHING MATERIALS

- A. Linear Polyurethane Coatings: Provide the following, or other products as acceptable.
 - 1. Acrylic Linear Polyurethane enamel: Two components, acrylic aliphatic isocyanate / acrylic polyurethane having ultraviolet (UV) inhibitors and engineered for exterior application by Matthews Paint Company or approved equal.
 - 2. Primer for Aluminum: Two-part component primer: One-coat Matthews 74-734 and 74-735 Metal Pretreat at .25 mils dry film thickness or one-coat Matthews 74-793 Spray Bond at .15 to .25 mils dry film thickness or Wyandotte / AKZO Grip-Guard Wash Primer (2Afy-31284) with Grip-Guard Wash Primer Hardener (10AFK-31285) combined and applied per manufacturer's specifications or approved equal (primer) for the application of the pre-approved and pre-formulated paint system.
 - 3. Primer for Steel: Two-part component primer: One-coat Matthews 74-734 and 74-735 Metal Pretreat at .25 mils dry film thickness or Wyandotte / AKZO Grip-Guard Wash Primer (2Afy-31284) with Grip-Guard Wash Primer Hardener (10AFK-31285) combined and applied per manufacturer's specifications or approved equal (primer) for the application of the pre- approved and pre-formulated paint system.
 - 4. Clear Sealers: Crystal clear matte polyurethane sealers By Matthews Paint Co. or approved equal. Sealers are to resist rust and corrosion associated with exposure to salt air. As required and of highest quality available, applied per manufacturer's specifications.
- B. Anodized Aluminum Components / Panels: If required, Signage Contractor shall provide anodized (application of aluminum oxide film coating in clear or colored dye finish) aluminum panels or parts to match Executive Architect's color, grain, finish, and specifications.

- C. Silk Screening Materials: Provide photo processed screening, arranged to furnish sharp and solid images without edge build up or bleeding of the coating. Pattern-cut screens may be used for non-repeat copy, provided that final image copy is equal to photoscreen quality. Provide only weather-resistant coating materials, compatible with the intended substrates. All silk-screened graphics are to be done with the finest screen size feasible for sharp, even reproduction.
- D. Vinyl Die-Cut and Pattern Cut-out Graphics: Use Scotchcal Opaque and Translucent film and Scotchcal Diamond Grade VIP Reflective film manufactured by 3M where specified. Use pressure-sensitive, non-yellowing, non-peeling and weather resistant vinyl as specified. Use approved fonts and equipment as specified.

2.05 FABRICATION OF SIGNS AND SUPPORTS

- A. General: Provide custom manufactured Sign assemblies, components completely fabricated and finished at factory before delivery to Project. Construct to accurate detail and dimensions as shown and as review on approved Shop Drawings. Fit and assemble the Work at the shop and mark the components as required to facilitate assembly during installation. Exposed fasteners on finished faces will not be allowed, unless specifically indicated. Waviness and oil canning of surfaces is not acceptable. Minimum material thickness is to be 0.090 inches. Conceal wiring, conduct and other electrical items within sign enclosures.
- B. Lettering: Cut and rout in a manner to produce true and clean edges and corners of finished letterforms. Letterforms having rounded positive or negative corners, nicked, cut, or ragged edges are not acceptable. Align letter forms to maintain a baseline parallel to the sign format. Maintain margins as indicated on the Drawings.
- C. Seams and Joints: The Signage Contractor shall cut walls and floors carefully and neatly repair them in an acceptable manner. Signage Contractor shall consult the Architect of Record in cases where cutting into a structural portion of the building is required so that satisfactory reinforcement may be provided. Added joints shall be ground filled and finished flush and smooth with adjacent work. Such seams shall be invisible after final finish has been applied. Spot welded joints shall not be visible on exterior of signs after final finish has been applied. No gaps, light leaks, waves, or oil canning will be permitted in Work. If any of these are evident, the Signage Contractor will be required to correct its Work or construct a new Sign at its own expense.
- D. Metal Signs and Supports: Fabricate exposed surfaces uniformly flat and smooth, without distortion, pitting, or other blemishes. Form exposed metal edges to a smooth radius. Permanently bond the laminated metal components and honeycomb core with adhesive or sealant in accordance with product manufacturer's recommendations. Grind exposed welds and rough areas to make flush with adjacent smooth surfaces.
- E. Welding: Make welds continuous. Comply with American Welding Society, Aluminum Association, and Copper Development Association standards for the type of metal used.
- F. Fasteners: Use exposed fasteners only if shown on the Construction Documents. Perform drilling and tapping at shop.
- G. Dissimilar Materials: Where metal surfaces will be in contact with dissimilar materials, coat the surfaces with epoxy paint or plate with zinc chromate, or provide other means of dielectric separation as recommended by manufacturer to prevent galvanic corrosion (i.e. Neoprene gasket as an isolation membrane)
- H. Castings: Exposed surfaces shall be uniformly free from porosity and roughness. Edges shall be filled and ground smooth. Faces shall be chemically etched and mechanically polished for specified finish.

- I. Galvanizing: Provide for steel components in exterior construction, and where noted in Drawings shall be galvanized. Complete the shop fabrication prior to application of the zinc coating. Remove mill scale and rust, clean and pickle the units as required for proper pretreatment of the surfaces.
- J. Hardware: Provide all incidental hardware necessary for the proper functioning of signs. External hardware shall conform to the external appearance of the Sign.
- K. Supports and Backing in Walls: Signage Contractor shall provide engineered Sign supports anchored to building structure where required and to meet requirements of applicable building codes. Support or backing requiring installation within the building wall construction shall be immediately relayed to the Architect of Record and LACCD's Representative for field coordination. Signage Contractor shall meet with the Contractor to review all requirements.
- L. Access Doors and Frames: Access doors and frames shall be flush with the material in which they occur, unless otherwise specified. Access doors and frames shall be provided upon prior written approval of the Architect. Each trade providing access doors and frames shall verify the need for fire rated doors on the Construction Drawings. Access doors in walls, partitions or ceilings shall bear UL fire rated labels of same fire rating. If access doors and frames are required to be exposed to view, they shall be chrome, brass, stainless steel, or other finish to match other finishes in the spaces in which they are to be installed, unless otherwise specified. Obtain LACCD's Representative's approval for location of each access door prior to placement.

2.06 SHOP APPLICATION OF SIGN FINISHES

- A. Sign Graphics: Provide the letters, numerals, symbols, and other graphics markings, using the finish materials shown. Apply the graphics neatly, uniformly proportioned and spaced, and accurate within the dimensions indicated. Prepare the substrate surfaces and apply finish materials in accordance with manufacturers' instructions.
- B. Metal Finishes: Remove scratches, abrasions, dents, and other blemishes before applying finish. Apply the following to the fabricated Work, with texture and reflectivity as required to match the Architect's sample.
- C. Linear Polyurethane Finishes: Clean the surfaces as required for proper adhesion of coatings. Use 3M Co. "Scotch Brite" pads with cleanser and water, and/or chemically treat as recommended by paint manufacturer to remove deleterious film or residue.
- D. Linear Polyurethane Paint: Provide pretreatment and primer in accordance with manufacturer's recommendation. Add ultraviolet inhibitors to paint subject to sunlight exposure.
- E. Clear Linear Polyurethane Finish: Provide pretreatment, primer, and matte or semi-gloss finish coatings in accordance with manufacturer's recommendations. Apply 1.5 to 2.0 mils (0.0375 to 0.050 mm) dry film thickness.

2.07 GRAPHIC APPLICATION

- A. Preparation: Surfaces to receive the graphic markings shall be clean, dry, and otherwise made ready for application of the materials. Accurately measure and lay out the required marking configurations as indicated on drawings.
- B. Vinyl Die-cut and Pattern-cut Graphics: Use pressure sensitive, non-yellowing, non-peeling and weather resistant vinyl adhesive letters or images, custom flood coated as required, die cut from ScotchCal or ScotchLite as manufactured by 3M Company. Apply in strict accordance with manufacturer's instructions. Make uniformly smooth and free from bubbles, wrinkles, stretching and blemishes.

- C. Painted or Silk-screened Graphics: All graphics shall be applied using photo processed screens from camera ready art, arranged to furnish sharp and solid images without build-up or bleeding of the coating. Comply with coating manufacturer's application instructions. Provide proper type of primer to suit each substrate and obtain a permanent bond. Verify compatibility of each substrate with the coatings to be used in the Work. Apply the markings with neat edges, minimum 3 mils (0.075 mm) dry film thickness and as required to obtain solid markings without voids.
- D. Acid-Etched Graphics and Typography: Acid-etched typography and graphic imagery must be an average of 1/16" deep, with clean, crisp, sharp edges; ragged or soft (polished out) edges will be rejected. Acid baths used for etching should be fresh and used in an environment and temperature that will provide the highest quality etched images. Color fill as indicated by the S/P color and finish schedule, keeping inks and fills true to the edges of letterforms / graphics.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Inspect all surfaces to receive signage and report all defects that would interfere with signage installation.
- B. Starting Work implies acceptance of surfaces as satisfactory.
- C. Verify all conditions and sign dimensions in field. Contractor to review and study architectural, landscape, lighting, electrical and related plans to ensure that all proposed signs can be installed and supported. Verification of conditions and sign dimensions to be completed prior to sign fabrication and reviewed with the architect.

3.02 DEMOLITION

- A. Existing signage to be removed and responsibly junked.
- B. Installation of new signage to be installed immediately after any demolition.
- C. Temporary signage, if necessary, is to conform with LACCD Graphic Standards for Temporary Signage
- D. Unused data and/or electrical feeds to be coordinated with LACCD for proper terminations.
- E. Any surfaces damaged should be repaired and painted/patched to match adjacent surface.
- F. Concrete and floor surfaces to be repaired in coordination with the LACCD.

3.03 INSTALLATION

- A. Install signage upon acceptance by the LACCD of material and substantial completion of job site area to receive such materials.
- B. Special Precautions: Guard against damaging existing pavements and planting where signage is to be installed.
- C. Footings beneath topping surface shall be installed and located prior to top surface installation.
- D. Prior to installation, check all components, nuts, bolts, and other connections for proper alignment, fit and any damage. Replace damaged or defective components.

- E. Prior to installation, confirm all electrical locations and requirements with the LACCD.

3.04 CLEAN UP

- A. Keep areas of work clean, neat, and orderly at all times. Clean surfaces, inside and out. Use approved cleaners, if necessary, to remove dirt.
- B. Protective coverings and strippable films shall be removed at a time that will afford the greatest protection of the furniture. Surfaces shall be cleaned to remove excess glazing and sealant compounds, dirt, and other substances.
- C. Upon completion of work and before final acceptance, remove tools, surplus materials, apparatus, and debris from the site. Leave the site in a neat, clean condition, acceptable to the Engineer. Wash, clean, and leave paved areas without stains.

3.05 FINAL INSPECTION AND ACCEPTANCE

- A. Upon completion of work, the LACCD will perform a final inspection for acceptance.
- B. All unused mock-ups and unused submittals shall be removed from site prior to final acceptance.
- C. Submit operation manuals, tools, and keys as specified in this Section.

END OF SECTION

SECTION 10 21 13

PHENOLIC-CORE TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Phenolic-core toilet compartments.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for supports that attach [ceiling-hung compartments] [floor-and-ceiling-anchored compartments] [and] [post-to-ceiling screens] to overhead structural system.
2. Section 06 10 00 "Rough Carpentry" for [blocking] [overhead support of floor-and-ceiling-anchored compartments] [and] [overhead support of post-to-ceiling screens].
3. Section 09 22 16 "Non-Structural Metal Framing" for blocking.
4. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.02 COORDINATION

- A. Coordinate requirements for [overhead supports,]blocking, reinforcing, and other supports concealed within wall[and ceiling] to ensure that toilet compartments can be supported and installed as indicated.

1.03 ACTION SUBMITTALS

A. Product Data.

1. Phenolic-core toilet compartments.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show [ceiling grid, ceiling-mounted items, and] overhead support or bracing locations.
6. <Insert requirements>.

- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

- D. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.
 - 1. Size: [Manufacturers' standard size] <Insert size>.
- E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.
- F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For toilet compartments.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Door Hinges: [One] <Insert number> hinge(s) with associated fasteners.
 - 2. Latch and Keeper: [One] <Insert number> latch(es) and keeper(s) with associated fasteners.
 - 3. Door Bumper: [One] <Insert number> door bumper(s) with associated fasteners.
 - 4. Door Pull: [One] <Insert number> door pull(s) with associated fasteners.
 - 5. Fasteners: [10] <Insert number> fasteners of each size and type.

1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain phenolic-core toilet compartments from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: [25] [75] [200] or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf (1112 N) applied at any direction and at any point, without deformation of panel.
 - C. Regulatory Requirements: Comply with applicable provisions in [the USDOJ's "2010 ADA Standards for Accessible Design"] [and] [ICC A117.1] <Insert accessibility regulation> for toilet compartments designated as accessible.
- 2.03 PHENOLIC-CORE TOILET COMPARTMENTS <INSERT DRAWING DESIGNATION>
- A. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - B. Toilet-Enclosure Style: [Overhead braced] [Floor anchored] [Ceiling hung] [Floor-and-ceiling anchored][, privacy type].
 - C. Entrance-Screen Style: [Overhead braced] [Floor anchored] [Ceiling hung] [Floor-and-ceiling anchored].
 - D. Urinal-Screen Style: [Wall hung] [Floor anchored] [Overhead braced] [Post to ceiling].
 - E. Door, Panel, and Pilaster Construction: Solid phenolic-core material with melamine facing on both sides fused to substrate during manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.[Provide with no-sightline system consisting of door and pilaster lapped edges on strike side of door and door and pilaster lapped edges on hinge side of door (unless continuous hinge is used).]
 - F. Entrance-Screen Construction: Matching panel construction.
 - G. Urinal-Screen Construction: Matching panel construction.
 - H. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
 - I. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
 - J. Urinal-Screen Post: Manufacturer's standard post design of [monolithic phenolic-core urinal screen cutout at bottom to form a post] [material matching the thickness and construction of pilasters] [or] [1-3/4-inch- (44-mm-) square, aluminum tube with satin finish] <Insert requirement>; with shoe [and sleeve (cap)] matching that on the pilaster.
 - K. Brackets (Fittings):
 1. Stirrup Type: Ear or U-brackets, stainless steel.
 2. Full-Height (Continuous) Type: Manufacturer's standard design, stainless steel.
 - L. Phenolic Compartment Finish: [One color] [Two colors] in each room.
 1. Dark-Core Phenolic: Manufacturer's standard dark color core and edge.
 - a. Facing Sheet Color: [As indicated by manufacturer's designations] [As selected by Architect from manufacturer's full range] <Insert color>.
 2. Through-Color Phenolic: Manufacturer's standard solid through-color.
 - a. Color: [As indicated by manufacturer's designations] [As selected by Architect from manufacturer's full range] <Insert color>.

2.04 HARDWARE AND ACCESSORIES

- A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.[Mount with through bolts.]
1. Hinges: [Manufacturer's stainless steel, surface-mounted, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees] [Manufacturer's stainless steel continuous, cam type that swings to a closed or partially open position] [Manufacturer's stainless steel continuous, spring-loaded type] [Manufacturer's standard] <Insert requirement>, allowing emergency access by lifting door.
 2. Latch and Keeper: Manufacturer's standard stainless steel, surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.
 3. Coat Hook: Manufacturer's standard stainless steel combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.
 4. Door Bumper: Manufacturer's standard stainless steel, rubber-tipped bumper at outswinging doors.
 5. Door Pull: Manufacturer's standard stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.
- B. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.
1. Hinges: Manufacturer's minimum 0.062-inch- (1.59-mm-) thick, stainless steel [surface-mounted, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees] [continuous, cam type that swings to a closed or partially open position] [continuous, spring-loaded type] [vault type] <Insert requirement>, allowing emergency access by lifting door. Mount with through bolts.
 2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible. Mount with through bolts.
 3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
 4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at outswinging doors. Mount with through bolts.
 5. Door Pull: Manufacturer's heavy-duty, cast stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible. Mount with through bolts.
- C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.05 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless Steel Castings: ASTM A743/A743M.

2.06 FABRICATION

- A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Ceiling-Hung Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.
- E. Floor-and-Ceiling-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- F. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment nuts at [tops and] bottoms of posts. Provide shoes [and sleeves (caps)] at posts to conceal anchorage.
- G. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, inswinging doors for standard toilet enclosures and 36-inch- (914-mm-) wide, outswinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for toilet enclosures designated as accessible.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
 - a. Pilasters and Panels or Screens: 1/2 inch.
 - b. Panels or Screens and Walls: 1 inch.
 2. Stirrup Brackets: Secure panels or screens to walls and to pilasters with no fewer than [two brackets attached] [three brackets attached at midpoint and] near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
 3. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.
- E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
- F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.03 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION

SECTION 10 22 39
FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Operable acoustical panel partitions.
2. Operable fire-rated panel partitions.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
2. Section 09 29 00 "Gypsum Board" for fire-rated assemblies and sound barrier construction above the ceiling at track.
3. Section 10 22 26.13 "Accordion Folding Partitions" for accordion-type folding partitions having a pantograph mechanism and outer flexible covering, or narrow, vertically hinged segments.
4. Section 10 22 39.13 "Folding Glass-Panel Partitions" for operable panel partitions made of glass panels.
5. Electrical and communications Sections for electrical service and connections for motor operators, controls, and limit switches and for system disconnect switches.

1.02 DEFINITIONS

- A. NIC: Noise Isolation Class.
- B. NRC: Noise Reduction Coefficient.
- C. STC: Sound Transmission Class.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Operable acoustical panel partitions.
2. Operable fire-rated panel partitions.

B. Shop Drawings: For operable panel partitions.

1. Include plans, elevations, sections, attachment details **[, and numbered panel installation sequence]**.

2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 3. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.
1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:
1. Textile Facing Material: Full width by not less than 36-inch-long section of **[fabric]** **[carpet]** from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
 2. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches square.
 3. Panel Edge Material: Not less than 3 inches long.
 4. Chair Rail: Manufacturer's standard-size unit, 6 inches long.
 5. Glass: Units 12 inches square.
 6. Hardware: One of each exposed door-operating device.
- E. Delegated Design Submittals: For operable panel partitions.
1. Include design calculations for seismic restraints that brace tracks to structure above.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Partition track, track supports and bracing, switches, turning space, and storage layout.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. HVAC ductwork, outlets, and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Smoke detectors.
 - f. Access panels.
 - g. <Insert item>.
 6. Plenum [fire] [smoke] [and] [acoustical] barriers.
- B. Setting Drawings: For embedded items and cutouts required in other work **[, including support-beam, mounting-hole template]**.
- C. Qualification Data: For [Installer] [testing agency].

- D. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:
 - 1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, in accordance with ASCE/SEI 7.
 - 2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of operable panel partition.
 - 1. Include approval letter signed by manufacturer acknowledging Owner-furnished panel facing material complies with requirements.
- F. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.
- G. Field quality-control reports.
- H. Sample Warranty: For manufacturer's special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.
 - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - b. Seals, hardware, track, track switches, carriers, and other operating components.
 - c. Electric operator and controls.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Faulty operation of operable panel partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period: **[Two] [Five] [10] <Insert number>** years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic bracing of tracks to structure above.
- B. Seismic Performance: Operable panel partitions are to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>**.
1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."
- C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties in accordance with test methods indicated:
1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance in accordance with ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
 2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance in accordance with ASTM C423, and rated for not less than the NRC indicated.
 3. Noise-Isolation Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC in accordance with ASTM E336, determined by ASTM E413, and rated for **[10 dB less than STC value indicated] <Insert value>**.
- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: **[25] <Insert value>** or less.
 - b. Smoke-Developed Index: **[450] <Insert value>** or less.
 2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with **[NFPA 265 Method B Protocol] [or] [NFPA 286]**.

- E. Fire Resistance: Provide fire-rated operable panel partition assemblies **[including pass doors]** complying with NFPA 80, based on testing in accordance with UL 10B for fire-rated door assemblies.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Pass doors in fire-rated operable panel partition assemblies are to meet positive-pressure requirements.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 OPERABLE ACOUSTICAL PANEL PARTITIONS

- A. Operable Acoustical Panel Partitions **<Insert drawing designation>**: Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
- B. Panel Operation: **[Manually operated, individual] [Manually operated, paired] [Manually operated, continuously hinged] [Electrically operated, continuously hinged]** panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 - 1. Panel Width: **[Standard widths] [Equal widths] [As indicated]**.
- E. STC: Not less than **[38] [41] [45] [47] [50] [52] [54] [56]** **<Insert number>**.
- F. NRC: Not less than **[0.50] [0.60] [0.65] [0.90]** **<Insert number>**.
- G. Panel Weight: **[8 lb/sq. ft.] [10 lb/sq. ft.] [12 lb/sq. ft.]** **<Insert value>** maximum.
- H. Panel Thickness: **[Maximum] [Minimum] [Nominal]** dimension of **[3 inches] [3-1/2 inches] [4 inches]** **<Insert dimension>**.
- I. Panel Materials:
 - 1. Steel Frame: Steel sheet, [manufacturer's standard] **[0.0508-inch] [0.0641-inch] [0.0747-inch]** **<Insert dimension>** nominal minimum thickness for uncoated steel.
 - 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, [manufacturer's standard] **[0.0299-inch] [0.0359-inch] [0.0478-inch] [0.0598-inch] [0.0747-inch]** **<Insert dimension>** minimum nominal thickness for uncoated steel.

3. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B221 for extrusions; manufacturer's standard strengths and thicknesses for type of use.
 - a. Frame Reinforcement: Manufacturer's standard steel or aluminum.
4. Gypsum Board: ASTM C1396/C1396M.
5. Cement Board: ASTM C1288.
6. Particleboard: ANSI A208.1.
7. Medium-Density Fiberboard: ANSI A208.2.
8. Plywood: DOC PS 1.

J. Panel Closure: Manufacturer's standard unless otherwise indicated.

1. Initial Closure: [Resilient, bulb-shaped acoustical seal] [Fixed jamb] [As indicated] <Insert description>.
2. Final Closure: [Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal] [Hinged jamb closure] [Hinged communicating panel] [Fixed jamb] [Angle jamb] [Resilient, bulb-shaped acoustical seal] <Insert description>.

K. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

1. Hinges: [Manufacturer's standard] [Concealed (invisible)] <Insert type>.
2. <Insert hardware requirement>.

L. Finish Facing: [Owner furnished] [Vinyl-coated fabric wall covering] [Carpet wall covering] [Fabric wall covering] [High-pressure decorative laminate] [Wood veneer] [Paint] <Insert finish>.

2.03 OPERABLE FIRE-RATED PANEL PARTITIONS

- A. Operable Fire-Rated Panel Partitions <Insert drawing designation>: Fire-rated, acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
- B. Panel Operation: Manually operated, [individual] [paired] panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable fire-rated panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 1. Panel Width: [Standard widths] [Equal widths] [As indicated].
- E. Fire Rating: [1] <Insert number> hour(s).

- F. STC: Not less than [38] [41] [45] [47] [50] [52] [54] <Insert number>.
- G. NRC: Not less than [0.50] [0.60] [0.65] [0.90] <Insert number>.
- H. Panel Weight: [**8.5 lb/sq. ft.**] [**10 lb/sq. ft.**] [**12 lb/sq. ft.**] <Insert value> maximum.
- I. Panel Thickness: [Maximum] [Minimum] [Nominal] dimension of [**3 inches**] [**3-1/2 inches**] [**4 inches**] <Insert dimension>.
- J. Panel Materials:
1. Steel Frame: Steel sheet, [manufacturer's standard] [**0.0508-inch**] [**0.0641-inch**] [**0.0747-inch**] <Insert dimension> nominal minimum thickness for uncoated steel.
 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, [manufacturer's standard] [**0.0299-inch**] [**0.0359-inch**] [**0.0478-inch**] [**0.0598-inch**] [**0.0747-inch**] <Insert dimension> minimum nominal thickness for uncoated steel.
- K. Panel Closure: Manufacturer's standard fire-rated closure unless otherwise indicated.
1. Initial Closure: [Resilient, bulb-shaped acoustical seal] [Fixed jamb] [As indicated] <Insert description>.
 2. Final Closure: Fire-rated, [constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal] [hinged jamb closure] [hinged communicating panel] [fixed jamb] [angle jamb] [resilient, bulb-shaped acoustical seal] <Insert description>.
- L. Hardware: Manufacturer's standard as required to operate fire-rated operable panel partition and accessories; with decorative, protective finish.
1. Hinges: [Manufacturer's standard] <Insert type>.
 2. <Insert hardware requirement>.
- M. Finish Facing: [Owner furnished] [Vinyl-coated fabric wall covering] [Carpet wall covering] [Fabric wall covering] [High-pressure decorative laminate] [Wood veneer] [Paint] <Insert finish>.

2.04 SEALS

- A. Description: Seals that produce operable panel partitions complying with performance requirements and the following:
1. Manufacturer's standard seals unless otherwise indicated.
 2. Seals made from materials and in profiles that minimize sound leakage.
 3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking [**steel**] astragals mounted on each edge of panel, with continuous, resilient acoustical seal.

- C. Horizontal Top Seals: [Continuous-contact, resilient seal exerting uniform constant pressure on track] [or] [resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended].
- D. Horizontal Bottom Seals:
1. Manufacturer's standard continuous-contact seal exerting uniform constant pressure on floor.
 2. Resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
 - a. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than **[1-1/2 inches] [2 inches] [4 inches] [6 inches]** between retracted seal and floor finish.
 - b. Mechanically Operated for Fire-Rated Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than **[1-1/2 inches] [2 inches] [4 inches]** between retracted seal and floor finish.
 - c. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than **[1 inch] [1-1/2 inches] [2 inches]** between retracted seal and floor finish.

2.05 PANEL FINISH FACINGS

- A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
1. Apply [one-piece, seamless] facings free of air bubbles, wrinkles, blisters, and other defects, [with edges tightly butted, and] [with invisible seams complying with Shop Drawings for location, and] with no gaps or overlaps. Horizontal [butted edges] [seams] are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
 2. Where facings with [directional or repeating patterns or directional weave] [directional, repeating, or matching grain] are indicated, mark facing top and attach facing in same direction.
 3. Match facing pattern 72 inches above finished floor.
- B. Owner-Furnished Facing Material: <Insert requirements>.
- C. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with WA-101, **[Type I-Light Duty] [Type II-Medium Duty] [Type III-Heavy Duty]**; Class A.
1. Total Weight: <Insert value>.
 2. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.

3. Color/Pattern: [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color/pattern>.
- D. Carpet Wall Covering: Manufacturer's standard [**nonwoven, needle-punched carpet with fibers fused to backing**], from same dye lot, treated to resist stains.
 1. Color/Pattern: [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color/pattern>.
- E. Fabric Wall Covering: [Manufacturer's standard fabric] [100 percent polyolefin woven fabric] <Insert fabric description>, from same dye lot, treated to resist stains.
 1. Color/Pattern: [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color/pattern>.
- F. High-Pressure Decorative Laminate: ISO 4586-3, Horizontal grade.
 1. Color/Pattern: [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color/pattern>.
- G. Wood Veneer: Laminated to [**noncombustible**] [**fire-retardant-treated wood**] core with moisture-resistant adhesive.
 1. Species and Cut: [Maple, plain sliced] [Poplar, plain sliced] [White oak, rift cut] [White ash, plain sliced] [As indicated] [As selected by Architect from manufacturer's full range] <Insert species and cut>.
 2. Matching of Adjacent Veneer Leaves: [**Book**] [**Slip**] [**Random**] match.
 3. Veneer Matching within Panel Face: [**Running**] [**Balance**] [**Center-balance**] match.
 4. Panel-Matching Method: [No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels] <Insert requirement>.
 5. Vertical Panel-Matching Method: [Continuous match; veneer leaves of upper panels are continuations of veneer leaves of lower panels] [Vertical book match; veneer leaves are individually book matched from lower panels to upper panels] [Vertical slip match; veneer leaves are individually slip matched from lower panels to upper panels] [Panel vertical book match; panels are book matched from lower panels to upper panels] [Panel vertical slip match; panels are slip matched from lower panels to upper panels].
 6. Wood-Veneer Finish:
 - a. [As specified in Section 09 93 00 "Staining and Transparent Finishing."] <Insert description.>
 - b. [Match Architect's sample] [As selected by Architect from manufacturer's full range], as follows:
 - 1) Type: [Transparent finish] [Transparent finish over stain] <Insert finish> over wood variety indicated.
- H. Paint: Manufacturer's standard [**factory-**] [**field-**] painted finish.
 1. Color: [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- I. Cap-Trimmed Edges: Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:

1. Steel, Painted: Finished with manufacturer's [standard neutral color] [color matching Architect's sample] [color as selected by Architect from manufacturer's full range].
 2. Aluminum: Finished with manufacturer's standard [mill] [clear anodic] [color anodic] finish.
- J. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.06 SUSPENSION SYSTEMS

- A. Tracks: Steel or aluminum **[mounted directly to overhead structural support,] [with adjustable steel hanger rods for overhead support,]** designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
 2. Head Closure Trim: As required for acoustical performance; [with factory-applied, decorative, protective finish] [primed for field finish].
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
1. Multidirectional Carriers: Capable of negotiating intersections without track switches.
- C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.
1. Curve-and-Diverter Switches: Allow radius turns to divert panels to an auxiliary track.
 2. L Intersections: Allow panels to change 90 degrees in direction of travel.
 3. T Intersections: Allow panels to pass through or change 90 degrees to another direction of travel.
 4. X Intersections: Allow panels to pass through or change travel direction full circle in 90-degree increments, and allow one partition to cross track of another.
 5. Multidirectional Switches: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.
 6. Center carrier stop.
- D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
- E. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.07 ELECTRIC OPERATORS

- A. Factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- B. Comply with NFPA 70.
- C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- D. Motor Electrical Characteristics:
 - 1. Horsepower: [Manufacturer's standard] <Insert value>.
 - 2. Volts: [115] [208] [230] [460] <Insert value>.
 - 3. Phase: [Single phase] [Polyphase].
 - 4. Hertz: 60.
- E. Control Stations: Two single-key-operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Open," "Close," and " **[Off] [Stop]**." Furnish two keys per station.
- F. Obstruction-Detection Devices: Equip each motorized operable panel partition with indicated automatic safety sensor that causes operator to immediately **[shut off motor] [stop and reverse direction]**.
 - 1. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.
 - 2. Sensor Mat: Electrically operated, contact-weight-sensitive safety mat in storage pocket area.
 - 3. Infrared Sensor System: Designed to detect an obstruction in partition's path and sound an audible alarm, without obstruction contacting partition.
- G. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.
- H. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.
- I. Electric Interlock: Equip each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:
 - 1. On storage pocket door, to prevent operation if door is not in fully open position.
 - 2. On partitions at location of convergence by another partition, to prevent operation if merging partitions are in place.

2.08 ACCESSORIES

- A. Pass Doors: Swinging door built into and matching panel **[materials,] [construction,] [acoustical qualities,] [fire rating,]** finish and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.
1. Accessibility Standard: Fabricate doors to comply with applicable provisions in **[the USDOJ's "2010 ADA Standards for Accessible Design"] [the ABA standards of the Federal agency having jurisdiction] [and] [ICC A117.1] <Insert requirement>**.
 2. Single Pass Door: **[36 by 80 inches] [36 by 84 inches]** <Insert dimensions>.
 3. Double Pass Door: **[72 by 80 inches] [72 by 84 inches]** <Insert dimensions>.
 4. Pass-Door Hardware: Equip pass door with the following:
 - a. Door Seals: **[Mechanically operated floor seal on panels containing pass doors] [Sweep floor seals]**.
 - b. **[Panic] [Fire exit]** hardware.
 - c. Concealed door closer.
 - d. Door Viewer: Installed with view in direction of swing.
 - e. Exit Sign: Recessed, self-illuminated.
 - f. Latchset: Passage set.
 - g. Lock, Key Operated: Key-operated lock with cylinder **[, keyed to master key system,]** operable from both sides of door. Include two keys per lock.
 - h. Lock, Deadlock: Deadlock to receive cylinder, operable from both sides of door. See **[Section 08 71 00 "Door Hardware"] [Section 08 71 11 "Door Hardware (Descriptive Specification)"]** for lock cylinder and keying requirements.
- B. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware **[and acoustical seals at soffit, floor, and jambs]**. Hinges in finish to match other exposed hardware.
1. Manufacturer's standard method to secure storage pocket door in closed position.
 2. Rim Lock, Key Operated: Key-operated lock cylinder **[, keyed to master key system,]** to secure storage pocket door in closed position. Include two keys per lock.
 3. Rim Lock, Deadlock: Deadlock to receive cylinder, to secure storage pocket door in closed position. See **[Section 08 71 00 "Door Hardware"] [Section 08 71 11 "Door Hardware (Descriptive Specification)"]** for lock cylinder and keying requirements.
- C. Windows: **[Manufacturer's standard] [As indicated]** <Insert requirement>.
1. Glass: Safety glass **[matching Architect's sample] [as selected by Architect from manufacturer's full range]** <Insert requirement>.
 2. Safety Glass Standard for Partition Panels: Glass products complying with testing requirements in 16 CFR 1201, Category II, or in ANSI Z97.1, Class A.
 3. Safety Glass Standard for Pass Doors: Glass products complying with testing requirements in 16 CFR 1201, Category II.
- D. Work Surfaces: Quantities, placement, and size indicated.

1. Surface: [Porcelain steel marker/projection surface] [Self-healing, tackable, vinyl-coated fabric wall covering, complying with WA-101, Type II-Medium Duty; Class A; laminated to natural cork tackboard] <Insert description>.
 2. Surface Color: [Matching Architect's sample] [As selected by Architect from manufacturer's full range] <Insert manufacturer's designation for color>.
 3. Size: [Full width and height of panel] [Full width of panel by **48 inches**] [**48 by 48 inches**] [As indicated on Drawings] <Insert dimensions>.
 4. Trim: [Aluminum slip-on or snap-on trim with no visible screws or exposed joints and with corners mitered to a neat, hairline joint] <Insert description>.
- E. Chalk Tray and Eraser Pocket: Aluminum with [mill] [clear anodic] [color anodic] finish.
- F. Chair Rails: <Insert material, finish, dimensions, and other characteristics not indicated on Drawings>. [Recessed] [Surface mounted] in locations indicated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF OPERABLE PANEL PARTITIONS

- A. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- B. Install panels in numbered sequence indicated on Shop Drawings.
- C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.
- E. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals. [**Perform test and make adjustments before NIC testing.**]

3.03 FIELD QUALITY CONTROL

- A. NIC Testing: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
 1. Testing Extent: Testing agency is to randomly select [one] <Insert number> operable panel partition installation(s) for testing.

2. Testing Methodology: Perform testing of installed operable panel partition for noise isolation in accordance with ASTM E336, determined by ASTM E413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

B. An operable panel partition installation will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust **[pass doors]** **[and]** **[storage pocket doors]** to operate smoothly and easily, without binding or warping.

C. Verify that safety devices are properly functioning.

3.05 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service is to include **[three]** **[six]** **[nine]** **[12]** months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION

SECTION 10 26 00

WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Wall guards.
2. Impact-resistant handrails.
3. Bed locators.
4. Corner guards.
5. End-wall guards.
6. Abuse-resistant wall coverings.
7. Door-edge protection.
8. Door-frame protection.
9. Door-hardware protection.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for [steel angle corner guards] [pipe guards] [and] [wheel guards].
2. Section 05 73 00 "Decorative Metal Railings" for metal handrails without plastic bumpers.
3. Section 06 40 23 "Interior Architectural Woodwork for solid-wood handrails, bumper rails, chair rails, or corner moldings without plastic bumpers.
4. **[Section 08 71 00 "Door Hardware"]** for metal **[and plastic]** protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.

B. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details. **[Show handrail design and support spacing required to withstand structural loads.]**

- C. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.
 - 1. Include Samples of accent strips and accessories to verify color selection.
- D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:
 - 1. Wall Guards: 12 inches long. Include examples of joinery, corners, **[end caps,] [top caps,]** and field splices.
 - 2. Handrails: 12 inches long. Include examples of joinery, corners, and field splices.
 - 3. Bed Locators: 12 inches long. Include example of end caps.
 - 4. **[Corner] [and] [End-Wall]** Guards: 12 inches long. Include example top caps.
 - 5. Abuse-Resistant Wall Covering: 6 by 6 inches square.
 - 6. Door-Surface Protection: 6 by 6 inches square.
 - 7. Door **[-Edge] [and] [-Frame]** Protectors: 12 inches long.
 - 8. Door-Knob and -Lever Protectors: Full-size unit of each type.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of handrail.
- B. Material Certificates: For each type of exposed plastic material.
- C. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials **[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. **[Wall-Guard] [and] [Handrail]** Covers: Full-size plastic covers of maximum length equal to **[2] <Insert number>** percent of each type, color, and texture of cover installed, but no fewer than **[two, 96-inch-] <Insert number and size>** long units.
 - 2. Bed-Locator Covers: Full-size plastic covers equal to **[2] <Insert number>** percent of each type, color, and texture of cover installed, but no fewer than **[two] <Insert number>** units.
 - 3. Corner-Guard Covers: Full-size plastic covers of maximum length equal to **[2] <Insert number>** percent of each type, color, and texture of cover installed, but no fewer than **[two, 48-inch-] <Insert number and size>** long units.

4. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

1.07 QUALITY ASSURANCE

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 2. Keep plastic materials out of direct sunlight.
 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.
 - b. Store [wall-guard] [bed-locator] [and] [handrail] covers in a horizontal position.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
 - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
 2. Warranty Period: **[Five]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products **[of each type]** from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in **[the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities]** **[and]** **[ICC A117.1]** <Insert requirement>.

2.03 WALL GUARDS

- A. Crash Rail <Insert drawing designation>: Heavy-duty [, **PVC-free**] assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.
1. Cover: Extruded rigid plastic, minimum 0.100-inch wall thickness; **[as follows:] [in dimensions and profiles indicated on Drawings.]**
 - a. Profile: **[Flat] [Convex]** <Insert description>.
 - 1) Dimensions: Nominal **[6 inches high by 1 inch deep] [8 inches high by 1 inch deep]** <Insert dimensions>.
 - 2) Surface: **[Uniform] [Uniform with coextruded accent inlay strip in contrasting color] [Grooved]** <Insert description>.
 - (a) Accent Inlay Strip: Nominal **[2 inches]** <Insert dimension> high by length of rail.
 - b. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Continuous Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.
 3. Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.
 4. Bumper: Continuous, resilient bumper cushion(s).
 5. End Caps and Corners: Prefabricated, injection-molded plastic; **[matching color] [contrasting with color]** <Insert color> cover; field adjustable for close alignment with snap-on cover.
 6. Accessories: Concealed splices and mounting hardware.
 7. Mounting: **[Surface mounted directly to wall] [Reveal mounted on bumper cushion(s)] [Extended mounting on injection-molded plastic mounting brackets].**
- B. Bumper Rail <Insert drawing designation>: Standard-duty [, **PVC-free**] assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.
1. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; **[as follows:] [in dimensions and profiles indicated on Drawings.]**
 - a. Profile: **[Half-round profile, nominal 1 inch high by 1 inch deep] [Rounded bullnose profile, nominal 4 inches high by 2 inches deep] [Angled profile with rounded bullnose front edge, nominal 4 inches high by 2 inches deep] [Flat profile, nominal 4 inches high by 1 inch deep]** <Insert profile and dimensions>.
 - b. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Continuous Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.
 3. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 4. Bumper: Continuous, resilient bumper cushion(s).
 5. End Caps and Corners: Prefabricated, injection-molded plastic; **[matching color] [contrasting with color]** <Insert color> cover; field adjustable for close alignment with snap-on cover.

6. Accessories: Concealed splices and mounting hardware.
 7. Mounting: [Surface mounted directly to wall] [Reveal mounted on bumper cushions] [Extended mounting on injection-molded plastic mounting brackets].
- C. Rub Rail **<Insert drawing designation>**: Standard-duty [, **PVC-free**] assembly consisting of continuous snap-on cover installed over concealed, continuous retainer.
1. Cover: Extruded plastic, minimum 0.078-inch wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Profile: [Half-round profile, nominal **1-1/8 inches high by 1-1/8 inches deep**] [Rounded bullnose profile, nominal **2 inches high by 1 inch deep**] <Insert profile and dimensions>.
 - b. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 2. Retainer: Minimum 0.0625-inch-thick, one-piece, extruded aluminum.
 3. End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
 4. Accessories: Concealed splices and mounting hardware.
 5. Mounting: [Surface mounted directly to wall] [Reveal mounted on bumper cushions].
- D. Wood Chair Rail with Bumper **<Insert drawing designation>**: Standard-duty [, **PVC-free**] assembly consisting of continuous sculpted, solid-wood rail, with continuous bumper insert installed in continuous recessed retainer.
1. Wood Rail: [**3-1/2 inches high by 7/8 inch deep**] [**5-1/2 inches high by 1-1/2 inches deep**] [Size and profile indicated on Drawings] <Insert dimensions>.
 - a. Wood Species: [Red oak] [Maple] [Ash] [Beech] <Insert species>.
 - b. Finish: [Clear] [Stained].
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 2. Bumper: Extruded plastic, minimum 0.078-inch wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Profile: [Half-round profile, nominal **2 inches high by 1 inch deep**] [Small rounded profile, nominal **1-1/8 inches high by 1-1/8 inches deep**] <Insert profile and dimensions>.
 - b. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 - c. End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
 3. Retainer: Minimum 0.0625-inch-thick, one-piece, extruded aluminum.
 - a. Finish: [Mill] [Brass colored].
 4. Accessories: Concealed splices and mounting hardware.
 5. Mounting: Surface mounted directly to wall.

- E. Opaque-Plastic Chair Rail <Insert drawing designation>: Standard-duty [, **PVC-free**] assembly consisting of continuous snap-on cover installed over continuous retainer.
- Cover: Extruded rigid plastic, minimum 0.070-inch wall thickness; **[as follows:] [in dimensions and profiles indicated on Drawings.]**
 - Profile: **[Rounded bullnose profile, nominal 2 inches high by 1 inch deep] [Half-round profile, nominal 1-1/8 inches high by 1-1/8 inches deep]** <Insert profile and dimensions>.
 - Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 - Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
 - Bumper: Continuous, resilient bumper cushion(s).
 - End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
 - Accessories: Concealed splices and mounting hardware.
 - Mounting: **[Surface mounted directly to wall] [Reveal mounted on bumper cushions].**
- F. Transparent-Plastic Chair Rail <Insert drawing designation>: Consisting of clear polycarbonate plastic sheet.
- Height: **[3 inches nominal] [4 inches nominal]** [As indicated on Drawings] <Insert dimension>.
 - Mounting: Surface mounted using flat-head countersunk screws through factory-drilled mounting holes.
- G. Rub Strip <Insert drawing designation>: Continuous [, **PVC-free**] strip, consisting of minimum **[0.040-inch-] [0.060-inch-]** <Insert dimension> thick, semirigid, plastic sheet wall-covering material.
- Height: **[8 inches nominal]** <Insert dimension>.
 - Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 - Mounting: Surface mounted with adhesive.

2.04 IMPACT-RESISTANT HANDRAILS

- A. Structural Performance: Handrails, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
- Uniform load of 50 lbf/ft. <Insert requirement> applied in any direction.
 - Concentrated load of 200 lbf applied in any direction.
 - Uniform and concentrated loads need not be assumed to act concurrently.
- B. Plastic, Impact-Resistant Handrails <Insert drawing designation>: Manufacturer's standard **[, PVC-free]** assembly consisting of snap-on plastic cover installed over continuous retainer.
- Cover: Minimum **[0.078-inch-] [0.100-inch-]** <Insert dimension> thick, extruded rigid plastic; **[as follows:] [in dimensions and profiles indicated on Drawings.]**

- a. Single Handrail: Cylindrical tube profile cover with continuous retainer; with mounting brackets supporting bottom of rail.
 - 1) Tube Diameter: **<Insert dimension>**.
 - b. Bumper Rail: Cover with **[flat]** **[sculpted with contoured thumb recess on]** **<Insert description>** front side; with 1-1/2-inch-diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
 - 1) Bumper-Rail Dimensions: Nominal **[5-1/2 inches high by 1-1/2 inches deep]** **[5-1/2 inches high by 2 inches deep]** **<Insert dimensions>**.
 - 2) Bumper Surface: **[Smooth]** **[Smooth with coextruded accent inlay strip in contrasting color]** **[Smooth with coextruded accent inlay strips in contrasting color]** **[Grooved]** **<Insert description>**.
 - 3) Accent Inlay Strip(s): **[One strip]** **[Two strips]**, nominal **[2 inches]** **<Insert dimension>** high by length of rail.
 - c. Double Handrail with Bumper-Rail Profile: Two tubes mounted above and below nominal, flat-faced bumper rail; each tube with 1-1/2-inch-diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
 - 1) Bumper-Rail Dimensions: Nominal **[4 inches high by 1-1/2 inches deep]** **<Insert dimensions>**.
 - 2) Bumper Surface: **[Smooth]** **[Smooth with coextruded accent inlay strip in contrasting color]** **[Smooth with coextruded accent inlay strips in contrasting color]** **[Grooved]** **<Insert description>**.
 - 3) Accent Inlay Strip(s): **[One strip]** **[Two strips]**, nominal **[2 inches]** **<Insert dimension>** high by length of rail.
 - d. Color and Texture: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color and texture>**.
2. Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.
 3. Mounting Bracket: Extended mounting on **[injection-molded plastic]** **[anodized-aluminum]** **<Insert description>** mounting brackets.
 4. End Caps and Corners: Prefabricated, injection-molded plastic; **[matching color]** **[contrasting with color]** **<Insert color>** cover; field adjustable for close alignment with snap-on cover.
 5. Accessories: Concealed splices, cushions, and mounting hardware.
- C. Combination Wood-Plastic Bumper Handrail **<Insert drawing designation>**: Manufacturer's standard **[, PVC-free]** assembly consisting of solid-wood handrail mounted above plastic bumper rail, both mounted on continuous retainer; with reveal between handrail and bumper serving as thumb recess on front side; with 1-1/2-inch-diameter gripping surface and finger recess on back side.
1. Wood Handrail: 1-1/2 inches in diameter; with matching end caps and corners.
 - a. Wood Species: **[Red oak]** **[Maple]** **[Ash]** **[Beech]** **<Insert species>**.
 - b. Finish: **[Clear]** **[Stained]**.
 - c. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color>**.

2. Bumper: Extruded rigid plastic, minimum **[0.078-inch-] [0.100-inch-]** wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Profile: [Flat] [Convex] <Insert profile> profile, nominal **[4 inches high by 1 inch deep]** <Insert profile and dimensions>.
 - b. Accent Inlay Strip: Nominal **[2 inches]** <Insert dimension> high by length of rail.
 - c. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 - d. End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
 3. Retainer: Minimum 0.0625-inch-thick, one-piece, extruded aluminum.
 4. Reveal: Extruded rigid plastic over aluminum retainer.
 - a. Color: [Brass] [Chrome] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 5. Accessories: Concealed splices, cushion(s), and mounting hardware.
- D. Wood Handrail with Bumper <Insert drawing designation>: Manufacturer's standard [, **PVC-free**] assembly consisting of continuous sculpted, solid-wood handrail, with bumper insert installed in continuous retainer recessed into the face of the wood.
1. Wood Handrail: **[As indicated on Drawings]** <Insert dimensions> with 1-1/2-inch-diameter gripping surface.
 - a. End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
 - b. Wood Species: [Red oak] [Maple] [Ash] [Beech] [Bamboo] <Insert species>.
 - c. Finish: [Clear] [Stained].
 - d. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 2. Bumper: Extruded plastic, minimum 0.078-inch wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings].
 - a. Profile: **[Half-round profile, nominal 2 inches high by 1 inch deep]** [Small rounded profile, nominal **1-1/8 inches high by 1-1/8 inches deep]** <Insert profile and dimensions>.
 - b. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 - c. End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
 3. Retainer: Minimum 0.0625-inch-thick, one-piece, extruded aluminum.
 - a. Finish: [Mill] [Brass colored].
 4. Accessories: Concealed splices and mounting hardware.

2.05 BED LOCATORS

- A. Bed Locators <Insert drawing designation>: Manufacturer's standard [, **PVC-free**] assembly consisting of continuous snap-on plastic cover installed over continuous retainer; with two bed-locator end caps and mounting hardware; cover designed to spring back when hit.
1. Cover: Extruded rigid plastic, minimum **[0.078-inch]** <Insert dimension> wall thickness.
 - a. Profile: Large, rounded **[angled]** **[bullnose]** profile, nominal 4 inches high by 2 inches deep.
 - b. Color and Texture: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.
 3. Bed-Locator End Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
 4. Mounting Type: **[Surface mounted on 1/2-inch-thick cushion spacers]** **[Extended mounting on injection-molded plastic mounting brackets]** **[Extended mounting on aluminum mounting brackets]**.

2.06 CORNER GUARDS

- A. Surface-Mounted, Plastic-Cover Corner Guards <Insert drawing designation>: Manufacturer's standard [, **PVC-free**] assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
1. Cover: Extruded rigid plastic, minimum **[0.078-inch]** **[0.100-inch]** <Insert dimension> wall thickness; **[as follows:]** **[in dimensions and profiles indicated on Drawings.]**
 - a. Profile: Nominal **[2-inch-long leg and 1/4-inch corner radius]** **[3-inch-long leg and 1/4-inch corner radius]** **[3-inch-long leg and 1-1/4-inch corner radius]** <Insert dimensions>.
 - b. Height: **[4 feet]** **[8 feet]** <Insert dimension>.
 - c. Color and Texture: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Continuous Retainer: **[Minimum 0.060-inch-thick, one-piece, extruded aluminum]** **[One-piece extruded plastic]**.
 3. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 4. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
- B. Flush-Mounted, Plastic-Cover Corner Guards <Insert drawing designation>: Manufacturer's standard [, **PVC-free**] assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface, installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
1. Cover: Extruded rigid plastic, minimum **[0.078-inch]** **[0.100-inch]** <Insert dimension> wall thickness; **[as follows:]** **[in dimensions and profiles indicated on Drawings.]**
 - a. Profile: Nominal **[2-inch-long leg and 1/4-inch corner radius]** **[3-inch-long leg and 1/4-inch corner radius]** **[3-inch-long leg and 1-1/4-inch corner radius]** <Insert dimensions>.

- b. Height: **[4 feet] [8 feet]** <Insert dimension>.
 - c. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
2. Continuous Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
 3. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 4. Aluminum Cove Base: Nominal **[4 inches] [6 inches]** <Insert dimension> high.
- C. Fire-Rated, Flush-Mounted, Plastic-Cover Corner Guards <Insert drawing designation>: Manufacturer's standard **[, PVC-free]** assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface, installed over continuous retainer and intumescent fire barrier; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
1. Fire Rating: **[1 hour] [2 hours]** [Same rating as wall in which corner guard is installed]; UL listed and labeled according to ASTM E1966 or UL 2079.
 - a. L-Rating at Smoke Barriers: Not exceeding 5.0 cfm/ft. of joint at 0.30 inch wg at both ambient and elevated temperatures according to UL 2079.
 2. Cover: Extruded rigid plastic, minimum **[0.078-inch] [0.100-inch]** <Insert dimension> wall thickness; **[as follows:] [in dimensions and profiles indicated on Drawings.]**
 - a. Leg: Nominal **[2 inches] [3 inches]**.
 - b. Corner Radius: **[1/4 inch] [1-1/4 inches]**.
 - c. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 3. Retainer: Minimum 0.070-inch-thick, one-piece, extruded aluminum.
 4. Aluminum Cove Base: Nominal **[4 inches] [6 inches]** <Insert dimension> high.
- D. Surface-Mounted, Opaque-Plastic Corner Guards <Insert drawing designation>: Fabricated as one piece from **[PVC plastic] [PVC-free plastic] [acrylic-modified vinyl sheet] [or] [opaque polycarbonate sheet]**; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
1. Wing Size: Nominal **[3/4 by 3/4 inch] [1-1/8 by 1-1/8 inches] [2-1/2 by 2-1/2 inches]** <Insert dimensions>.
 2. Mounting: **[Countersunk screws through factory-drilled mounting holes] [Adhesive]**.
 3. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
- E. Surface-Mounted, Transparent-Plastic Corner Guards <Insert drawing designation>: Fabricated as one piece from clear polycarbonate plastic sheet; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
1. Wing Size: Nominal **[3/4 by 3/4 inch] [1-1/8 by 1-1/8 inches] [2-1/2 by 2-1/2 inches]** <Insert dimensions>.
 2. Thickness: Minimum **[0.050 inch] [0.075 inch] [0.100 inch]** <Insert dimension>.
 3. Mounting: **[Countersunk screws through factory-drilled mounting holes] [Corner clips]**.

- F. Surface-Mounted, Metal Corner Guards <Insert drawing designation>: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
1. Material: Stainless-steel sheet, [Type 304] [Type 430].
 - a. Thickness: Minimum [0.0500 inch] [0.0625 inch] [0.0781 inch] <Insert dimension>.
 - b. Finish: [Directional satin, No. 4] [Bright annealed].
 2. Material: Extruded aluminum, minimum 0.0625 inch thick, with clear anodic finish.
 3. Material: Brass sheet, minimum 0.0500 inch thick, with [buffed, smooth specular] [fine satin] finish.
 4. Wing Size: Nominal [1-1/2 by 1-1/2 inches] [2-1/2 by 2-1/2 inches] [3-1/2 by 3-1/2 inches] <Insert dimensions>.
 5. Corner Radius: [1/8 inch] [3/4 inch] <Insert dimension>.
 6. Mounting: [Flat-head, countersunk screws through factory-drilled mounting holes] [Oval head, countersunk screws through factory-drilled mounting holes] [Adhesive].

2.07 END-WALL GUARDS

- A. Surface-Mounted, Plastic-Cover, End-Wall Guard <Insert drawing designation>: Manufacturer's standard [, PVC-free] assembly consisting of snap-on, resilient plastic cover installed over [continuous retainer] [continuous retainer at each corner, with end of wall covered by semirigid, abuse-resistant wall covering]; including mounting hardware.
1. Cover: Extruded rigid plastic, minimum [0.078-inch] [0.100-inch] wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Profile: Nominal [2-inch-long leg and 1/4-inch corner radius] [3-inch-long leg and 1/4-inch corner radius] [3-inch-long leg and 1-1/4-inch corner radius] <Insert dimensions>.
 - b. Height: [4 feet] [8 feet] <Insert dimension>.
 - c. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Match corner guards] <Insert color and texture>.
 2. Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
 3. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
- B. Flush-Mounted, Plastic-Cover, End-Wall Guard <Insert drawing designation>: Manufacturer's standard [, PVC-free] assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over [continuous retainer] [continuous retainer at each corner, with end of wall covered by semirigid, abuse-resistant wall covering]; including mounting hardware.
1. Cover: Extruded rigid plastic, minimum [0.078-inch] [0.100-inch] <Insert dimension> wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Profile: Nominal [2-inch-long leg and 1/4-inch corner radius] [3-inch-long leg and 1/4-inch corner radius] [3-inch-long leg and 1-1/4-inch corner radius] <Insert dimensions>.
 - b. Height: [4 feet] [8 feet] <Insert dimension>.

- c. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Match corner guards] <Insert color and texture>.
 2. Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
 3. Aluminum Cove Base: Nominal **[4 inches] [6 inches]** <Insert dimension> high.
- C. Fire-Rated, Flush-Mounted, Plastic-Cover, End-Wall Guard <Insert drawing designation>: Manufacturer's standard [, **PVC-free**] assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer and intumescent fire barrier; including mounting hardware; full wall height.
1. Fire Rating: [1 hour] [2 hours] [Same rating as wall in which end guard is installed]; UL listed and labeled according to UL 2079.
 2. Cover: Extruded rigid plastic, minimum **[0.078-inch] [0.100-inch]** <Insert dimension> wall thickness; [as follows:] [in dimensions and profiles indicated on Drawings.]
 - a. Leg: Nominal **[2 inches] [3 inches]** <Insert dimension>.
 - b. Corner Radius: **[1/4 inch] [1-1/4 inches]** <Insert dimension>.
 - c. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Match corner guards] <Insert color and texture>.
 3. Retainer: Minimum 0.070-inch-thick, one-piece, extruded aluminum.
 4. Aluminum Cove Base: Nominal **[4 inches] [6 inches]** <Insert dimension> high.
- D. Surface-Mounted, Metal, End-Wall Guards <Insert drawing designation>: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.
1. Material: Stainless-steel sheet, **[Type 304] [Type 430]**.
 - a. Thickness: Minimum **[0.0500 inch] [0.0625 inch] [0.0781 inch]** <Insert dimension>.
 - b. Finish: [Directional satin, No. 4] [Bright annealed].
 2. Material: Extruded aluminum, minimum 0.0625 inch thick, with clear anodic finish.
 3. Material: Brass sheet, minimum 0.0500 inch thick, with **[buffed, smooth specular] [fine satin]** finish.
 4. Wing Size: Nominal **[1-1/2 by 1-1/2 inches] [2-1/2 by 2-1/2 inches] [3-1/2 by 3-1/2 inches]** <Insert dimensions>.
 5. Corner Radius: **[1/8 inch] [3/4 inch]** <Insert dimension>.
 6. Mounting: [Flat-head, countersunk screws through factory-drilled mounting holes] [Oval head, countersunk screws through factory-drilled mounting holes] [Adhesive].
- 2.08 ABUSE-RESISTANT WALL COVERINGS
- A. Abuse-Resistant Sheet Wall Covering <Insert drawing designation>: Fabricated from semirigid, plastic sheet wall-covering material.
1. Size: **[48 by 96 inches]** for sheet] **[48 by 120 inches]** for roll] [As indicated] <Insert dimensions>.
 2. Sheet Thickness: **[0.022 inch] [0.028 inch] [0.040 inch] [0.060 inch] [0.080 inch] [0.093 inch] [0.125 inch]** <Insert dimension>.

3. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 4. Height: [Full wall] [Wainscot] [As indicated] <Insert dimension>.
 5. Trim and Joint Moldings: Extruded rigid plastic that matches wall-covering color.
 6. Mounting: Adhesive.
- B. Laminated, Impact-Resistant Wall Panels <Insert drawing designation>: Rigid wall panels consisting of semirigid, plastic sheet wall covering material factory laminated to high-impact-resistant core, with moisture-resistant vapor barrier factory laminated to reverse side of panel for stability.
1. Composition: [0.028-inch-thick plastic sheet laminated to 3/8-inch-thick particleboard or medium-density fiberboard core] [0.04-inch-thick plastic sheet laminated to 3/8-inch-thick particleboard or medium-density fiberboard core] <Insert description>.
 2. Sheet Size: [48 by 96 inches] [48 by 108 inches] [48 by 120 inches] [As indicated] <Insert dimensions>.
 3. Height: [Full wall] [Wainscot] [As indicated] <Insert dimension>.
 4. Sheet Edge: [Square] [Beveled].
 5. Trim and Joint Moldings: Extruded rigid plastic that matches wall-covering color.
 6. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 7. Mounting: Adhesive.
- 2.09 PLASTIC DOOR-PROTECTION PLATES
- A. General: Manufacturer's standard plastic products of thicknesses and sizes indicated.
1. Fire-Rated Doors: Where the tops of door-protection plates indicated for field installation on fire-rated doors are more than 16 inches above the door bottoms, provide door-protection plates complying with NFPA 80 that are listed and labeled by a qualified testing and inspection agency acceptable to authorities having jurisdiction.
- B. Full-Height Door-Surface Protection <Insert drawing designation>: Minimum [0.040-inch] [0.060-inch] [0.080-inch] <Insert dimension> wall thickness; with 90-degree bend for edge return to protect door edge.
1. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 2. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- C. Armor Plates <Insert drawing designation>: Minimum [0.040-inch] [0.060-inch] [0.080-inch] <Insert dimension> wall thickness; beveled four sides.
1. Size: [32 inches] [36 inches] [40 inches] [42 inches] <Insert dimension> high by door width, with allowance for frame stops.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.

3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- D. Kick Plates <Insert drawing designation>: Minimum **[0.040-inch] [0.060-inch] [0.080-inch]** <Insert dimension> wall thickness; beveled four sides.
1. Size: **[8 inches] [10 inches] [12 inches]** <Insert dimension> high by door width, with allowance for frame stops.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- E. Mop Plates <Insert drawing designation>: Minimum **[0.040-inch] [0.060-inch] [0.080-inch]** <Insert dimension> wall thickness; beveled four sides.
1. Size: **[4 inches] [6 inches]** <Insert dimension> high by 1 inch less than door width.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- F. Stretcher Plates <Insert drawing designation>: Minimum **[0.040-inch] [0.060-inch] [0.080-inch]** <Insert dimension> wall thickness; beveled four sides.
1. Size: **[6 inches] [8 inches]** <Insert dimension> high by door width, with allowance for frame stops.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- G. Push Plates <Insert drawing designation>: Minimum **[0.040-inch] [0.060-inch] [0.080-inch]** <Insert dimension> wall thickness; beveled four sides.
1. Size: **[12 inches high by 4 inches wide] [16 inches high by 4 inches wide]** <Insert dimensions>.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].
- 2.10 DOOR-EDGE PROTECTION
- A. Door Edging <Insert drawing designation>: Fabricated from extruded rigid plastic, minimum **[0.040-inch] [0.060-inch]** <Insert dimension> wall thickness; formed to fit over door edge without mortising.
1. Shape: **[L] [U]**.
 2. Color and Texture: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
 3. Mounting: [Adhesive] [Countersunk screws through factory-drilled mounting holes].

2.11 DOOR-FRAME PROTECTION

- A. Door-Frame Protector <Insert drawing designation>: One piece fabricated from extruded rigid plastic, minimum **[0.040-inch] [0.050-inch] [0.060-inch]** <Insert dimension> wall thickness; formed to fit entire door-frame profile.
1. Height: **[36 inches] [48 inches]** <Insert dimension>.
 2. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 3. Mounting: **[Adhesive] [Countersunk screws through factory-drilled mounting holes]**.
- B. Door-Frame Protector Assembly <Insert drawing designation>: Assembly consisting of snap-on plastic cover installed over continuous retainer; formed to fit half of door frame on opposite side of door swing.
1. Cover: Extruded rigid plastic, minimum 0.080-inch wall thickness; in dimensions and profiles indicated.
 - a. Height: **[36 inches] [48 inches]** <Insert dimension>.
 - b. Corner Radius: **[1/4 inch] [1-1/4 inches]**.
 - c. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.

2.12 DOOR-HARDWARE PROTECTION

- A. Door **[-Knob] [and] [-Lever]** Protector <Insert drawing designation>: Fabricated from injection-molded plastic, minimum 0.060-inch wall thickness.
1. Color and Texture: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and texture>.
 2. Mounting: Countersunk screws through factory-drilled mounting holes.

2.13 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- B. Polycarbonate Plastic Sheet: ASTM D6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. of notch when tested according to ASTM D256, Test Method A.
- C. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.
- D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- E. Adhesive: As recommended by protection product manufacturer.

2.14 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Curved Panels: Preform curved semirigid, abuse-resistant sheet wall covering in factory for radius and sheet thickness as follows:
 - 1. Sheet Thickness of 0.040 Inch: 24-inch radius.
 - 2. Sheet Thickness of 0.060 Inch: 36-inch radius.
 - 3. <Insert thickness and radius>.
- C. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- D. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
- E. Wood Handrails: Miter corners and ends of wood handrails for returns.

2.15 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances [**fire rating,**] and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.03 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings. **[If not indicated on Drawings, install at heights indicated below:]**
 - 1. Crash Rails: <Insert dimension> above finished floor.
 - 2. Bumper Rails: <Insert dimension> above finished floor.
 - 3. Rub Rails: <Insert dimension> above finished floor.
 - 4. Chair Rails: <Insert dimension> above finished floor.
 - 5. Handrails: <Insert dimension> above finished floor.
 - 6. Bed Locators: <Insert dimension> above finished floor.
 - C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches apart.
 - 3. Adjust **[end] [and] [top]** caps as required to ensure tight seams.
 - D. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.
 - E. Door-Frame Protectors: Install on both door jams.
 - F. Fire Doors: Install protection according to the listing of each item.
- 3.04 CLEANING
- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
 - B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

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SECTION 10 28 13
TOILET ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Toilet-compartment occupancy-indicator system.
3. Public-use shower room accessories.
4. Staff bathroom accessories.
5. Healthcare accessories.
6. Childcare accessories.
7. Underlatory guards.
8. Custodial accessories.
9. Hand-sanitizer dispensers.

B. Related Requirements:

1. Section 08 83 00 "Mirrors" for frameless mirrors.
2. Section 09 30 13 "Ceramic Tiling" for ceramic toilet and bath accessories.
3. Section 10 28 13.63 "Detention toilet Accessories" for accessories designed for installation in detention facilities.

1.02 ALLOWANCES

- A. See Section 01 21 00 "Allowances" for description of allowances affecting items specified in this Section.

1.03 UNIT PRICES

- A. See Section 01 22 00 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.04 ALTERNATES

- A. See Section 01 23 00 "Alternates" for description of alternates affecting items specified in this Section.

1.05 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.06 ACTION SUBMITTALS

- A. Product Data:
 - 1. Public-use washroom accessories.
 - 2. toilet-compartment occupancy-indicator system.
 - 3. Public-use shower room accessories.
 - 4. Private-use bathroom accessories.
 - 5. Healthcare accessories.
 - 6. Childcare accessories.
 - 7. Underlavatory guards.
 - 8. Custodial accessories.
 - 9. Hand-sanitizer dispensers.
- B. Product Data Submittals: for each product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Include electrical characteristics.
- C. Samples: for each exposed product and for each finish specified, full size.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- D. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.
- E. Delegated Design Submittals: for **[grab bars] [and] [shower seats]**.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.07 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: for manufacturer's special warranties.

1.08 CLOSEOUT SUBMITTALS

- A. Maintenance Data: for accessories to include in maintenance manuals.

1.09 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: **[10] [15]** <Insert number> years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for toilet-Compartment Occupancy-Indicator Systems: Manufacturer agrees to repair or replace toilet-compartment occupancy-indicator systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **[Five]** <Insert number> years from date of Substantial Completion.

- C. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **[Two] [Five] [10]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished Materials: <Insert products>.

2.01 MANUFACTURERS

- A. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2. Shower Seats: Installed units are able to resist **[250 lbf]** **[360 lbf]** **<Insert load>** concentrated load applied in any direction and at any point.

2.03 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain **[public-use washroom accessories]** **[each type of public-use washroom accessory]** from single source from single manufacturer.

- B. Toilet Tissue (Roll) Dispenser **<Insert drawing designation>**:

1. Description: **[Roll-in-reserve dispenser with hinged front secured with tumbler lockset]** **[Single-roll dispenser]** **[Double-roll dispenser]** **[Double-roll dispenser with shelf]** **<Insert description>**.
2. Mounting: **[Recessed]** **[Partition mounted, serving two adjacent toilet compartments]** **[Surface mounted]**.
3. Operation: **[Noncontrol delivery with standard spindle]** **[Noncontrol delivery with theft-resistant spindle]** **[Spindleless with tension-spring controlled delivery]** **[Spindleless with tension-spring controlled delivery and self-locking device extending through core that prevents core removal until roll is empty]** **[Eccentric-shaped, molded-plastic spindle revolves one-half revolution per dispensing operation for controlled delivery; core cannot be removed until roll is empty]** **<Insert description>**.
4. Capacity: Designed for 4-1/2 diameter tissue rolls.
5. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** **[Chrome-plated zinc alloy (zamac) or steel]** **[Satin-finish aluminum bracket with plastic spindle]** **<Insert material and finish>**.

- C. Combination toilet Tissue Dispenser **<Insert drawing designation>**:

1. Description: Combination unit with double-roll toilet tissue dispenser and the following:
 - a. Removable sanitary-napkin waste receptacle with self-closing, disposal-opening cover.
 - b. Seat-cover dispenser with minimum capacity of **[500]** **[1000]** **<Insert number>** single or half-fold seat covers.
 - c. Multiple roll dispenser must be vertical stacked.
2. Mounting: **[Recessed]** **[Surface mounted]** **[Partition mounted, dual access with two tissue rolls per compartment]** **[Partition mounted, dual access with two tissue rolls per compartment and with one side that mounts flush with partition of accessible compartment]**.
3. Toilet Tissue Dispenser Capacity: 4-1/2 diameter tissue rolls.
 - a. Do not use Jumbo-roll at accessible stalls or single user toilets.
4. Toilet Tissue Dispenser Operation: **[Noncontrol delivery with theft-resistant spindles]** **<Insert description>**.
5. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** **<Insert material and finish>**.

6. Lockset: Tumbler type.
- D. toilet Tissue (Jumbo-Roll) Dispenser <Insert drawing designation>:
1. Description: [One-roll unit] [Two-roll unit with sliding panel to expose other roll].
 2. Mounting: Surface mounted.
 3. Capacity: [9- or 10-inch-] <Insert dimension> diameter rolls.
 4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [ABS plastic, gray, with translucent front cover] <Insert material and finish>.
 5. Lockset: Tumbler type.
 6. Refill Indicator: Pierced slots at front.
- E. Paper towel (Folded) Dispenser <Insert drawing designation>:
1. Mounting: [Recessed] [Semi-recessed] [Deck mounted, recessed] [Surface mounted].
 2. Minimum Capacity: [400 C-fold or 525 multifold towels] [600 C-fold or 800 multifold towels] [400 single-fold towels] <Insert capacity>.
 3. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [ABS plastic, gray] <Insert material and finish>.
 4. Lockset: Tumbler type.
 5. Refill Indicator: Pierced slots at sides or front.
- F. Paper towel (Roll) Dispenser <Insert drawing designation>:
1. Description: [Lever-actuated] [Pull-towel single hand operation] mechanism that permits controlled delivery of paper rolls in preset lengths.
 2. Mounting: [Recessed] [Semi-recessed] [Surface mounted].
 3. Minimum Capacity: [8-inch- wide, 800-foot- long roll] <Insert capacity>.
 4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [ABS plastic, gray, with translucent front cover] <Insert material and finish>.
 5. Lockset: Tumbler type.
- G. Automatic Paper towel (Roll) Dispenser <Insert drawing designation>:
1. Description: Automatic motion-sensing mechanism with user-adjustable delay and paper towel length; [electrically operated, with adapter for 110 to 240 V ac power supply] [battery powered] <Insert description>.
 2. Mounting: [Recessed] [Semi-recessed] [Surface mounted].
 3. Minimum Capacity: [8-inch- wide, 800-foot- long roll] <Insert capacity>.

4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [ABS plastic, gray] <Insert material and finish>.
 5. Lockset: Tumbler type.
- H. Waste Receptacle <Insert drawing designation>:
1. Mounting: [Open top, recessed] [Self-closing disposal-opening cover, recessed] [Semi-recessed] [Surface mounted] [Wall mounted for corner installation] [Freestanding] [Undercounter] <Insert description>.
 2. Minimum Capacity: <Insert value>.
 3. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert material and finish>.
 4. Liner: [Reusable vinyl liner] <Insert liner description>.
 5. Lockset: Tumbler type for waste receptacle.
- I. Countertop-Mounted Circular Waste Chute <Insert drawing designation>:
1. OD: [6 inches] [7 inches] [9 inches] <Insert dimension>.
 2. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
 3. Waste Chute must not block required knee and toe space under sinks.
- J. Combination towel (Folded) Dispenser/Waste Receptacle <Insert drawing designation>:
1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
 2. Mounting: [Surface mounted] [Surface mounted with stainless steel collar] [Recessed] [Recessed with projecting receptacle] [Semi-recessed] [Under vanity] <Insert mounting>.
 - a. Designed for nominal [4-inch] [6-inch] wall depth.
 3. Minimum towel-Dispenser Capacity: [600 C-fold or 800 multifold paper towels] <Insert capacity>.
 4. Minimum Waste-Receptacle Capacity: [4 gal.] [12 gal.] <Insert value>.
 5. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert material and finish>.
 6. Liner: [Reusable, vinyl waste-receptacle liner] <Insert liner description>.
 7. Lockset: Tumbler type for towel-dispenser compartment [and waste receptacle].
- K. Combination towel (Roll) Dispenser/Waste Receptacle <Insert drawing designation>:

1. Description: Combination unit for dispensing preset length of roll paper towels, with removable waste receptacle.
 2. Towel Mechanism: [Lever] [Pull towel] [Automatic, electric sensor; with adapter for 110 to 240 V ac power supply] [Automatic, battery-operated sensor] <Insert description>.
 3. Mounting: [Recessed] [Semi-recessed] [Surface mounted].
 4. Minimum towel-Dispenser Capacity: [8-inch- wide, 800-foot- long roll] <Insert capacity>.
 5. Minimum Waste Receptacle Capacity: [8 gal.] [12 gal.] [15 gal.] <Insert value>.
 6. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert material and finish>.
 7. Liner: [Reusable, vinyl waste-receptacle liner] <Insert liner description>.
 8. Lockset: Tumbler type for towel dispenser compartment [and waste receptacle].
- L. Multipurpose Soap/towel Dispenser Unit <Insert drawing designation>:
1. Description: Combination unit for dispensing soap in [liquid or lotion] [lather] form and folded towels.
 2. Mounting: [Recessed, designed for nominal 4-inch wall depth] [Surface mounted with stainless steel collar and mirror] <Insert mounting>.
 3. Minimum Soap-Dispenser Capacity: [80 oz.] <Insert value>.
 4. Minimum towel-Dispenser Capacity: [600 C-fold or 800 multifold towels] [1000 single-fold towels] <Insert capacity>.
 5. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert material and finish> for unit body and soap valve.
 6. Lockset: Tumbler type.
- M. Warm-Air Hand Dryer <Insert drawing designation>:
1. Description: Standard-speed, warm-air hand dryer.
 2. Mounting: [Recessed] [Semi-recessed] [Surface mounted].
 - a. Protrusion Limit: Installed unit protrudes maximum 4 inches from wall surface.
 3. Operation: [touch-button] [Infrared-sensor] activated with timed power cutoff switch.
 - a. Automatic Shutoff: at [40] [80] [120] <Insert number> seconds.
 4. Maximum Sound Level: [63] [67] [87] <Insert number> dB.
 5. Cover Material and Finish: [Steel, with white enamel finish] [Cast iron, with enamel finish in color selected by Architect] [Chrome-plated steel] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Molded plastic, gray] [Molded plastic, white] <Insert material and finish>.

6. Electrical Requirements: [115 V, 13 A, 1500 W] [115 V, 15 A, 1725 W] [115 V, 20 A, 2300 W] [208 to 240 V, 9 to 10 A, 1900 to 2300 W] <Insert requirements>.

N. High-Speed Air Hand Dryer <Insert drawing designation>:

1. Description: High-speed, [warm] [unheated]-air hand dryer for rapid hand drying.
2. Mounting: [Recessed] [Semi-recessed] [Surface mounted].
 - a. Protrusion Limit: Installed unit protrudes maximum 4 inches from wall surface.
3. Operation: Infrared-sensor activated with timed power cutoff switch.
 - a. Average Dry Time: [12] <Insert number> seconds.
 - b. Automatic Shutoff: at [60] <Insert number> seconds.
4. Maximum Sound Level: [69] [75] <Insert number> dB.
5. Cover Material and Finish: [Steel, with white enamel finish] [Cast iron, with enamel finish in color selected by Architect] [Chrome-plated steel] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Molded plastic, gray] [Molded plastic, white] <Insert material and finish>.
6. Electrical Requirements: [115 V, 13 A, 1500 W] [115 V, 15 A, 1725 W] [115 V, 20 A, 2300 W] [208 to 240 V, 9 to 10 A, 1900 to 2300 W] <Insert requirements>.

O. Multiple-Airflow Hand Dryer <Insert drawing designation>:

1. Description: Multiple-airflow hand dryer, using two or more airstreams for rapid hand drying [with heating unit on-off control].
2. Mounting: [Surface mounted] <Insert requirements>.
3. Operation: Electronic-sensor activated with timed power cutoff switch.
 - a. Average Dry Time: [12] <Insert number> seconds.
 - b. Automatic Shutoff: at [60] <Insert number> seconds.
4. Maximum Sound Level: [56] [75] <Insert number> dB.
5. Water Collection: Removable reservoir.
6. Filter: HEPA, replaceable.
7. Cover Material and Finish: [Steel, with white enamel finish] [Cast iron, with enamel finish in color selected by Architect] [Chrome-plated steel] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Molded plastic, gray] [Molded plastic, white] <Insert material and finish>.
8. Electrical Requirements: [115 V, 13 A, 1500 W] [115 V, 15 A, 1725 W] [115 V, 20 A, 2300 W] [208 to 240 V, 9 to 10 A, 1900 to 2300 W] <Insert requirements>.

P. Soap Dispenser <Insert drawing designation>:

1. Description: Designed for manual operation and dispensing soap in **[liquid or lotion]** **[lather]** form.
 2. Mounting: **[Horizontally oriented, recessed]** **[Horizontally oriented, surface mounted]** <Insert mounting>.
 3. Manual deck mounted pumps are not compliant, Do not use.
 4. Capacity: <Insert value>.
 5. Materials: <Insert requirements>.
 6. Lockset: Tumbler type.
 7. Refill Indicator: Window type.
- Q. Automatic Soap Dispenser <Insert drawing designation>:
1. Description: Automatic dispenser with infrared sensor to detect presence of hands; **[electrically operated, with adapter for 110 to 240 V ac power supply]** **[battery powered]**; designed for dispensing soap in **[liquid or lotion]** **[lather]** form.
 2. Mounting: **[Deck mounted on vanity]** **[Deck mounted on lavatory]** **[Surface mounted]**.
 3. Capacity: <Insert value>.
 4. Materials: <Insert requirements>.
 5. Refill Indicator: LED indicator.
 6. Low-Battery Indicator: LED indicator.
- R. Grab Bar <Insert drawing designation>:
1. Mounting: Flanges with **[concealed]** **[exposed]** fasteners.
 2. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
 3. OD: **[1-1/4 inches]** **[1-1/2 inches]**.
 4. Configuration and Length: **[As indicated on Drawings]** **[Straight, 36 inches long]** <Insert configuration and length>.
- S. Sanitary-Napkin and Tampon Vendor <Insert drawing designation>:
1. Mounting: **[Fully recessed, designed for 4-inch wall depth]** **[Semi-recessed]**.
 2. Capacity: <Insert description>.
 3. Operation: **[No coin (free)]** **[Single coin (25 cents)]** **[Two coins (50 cents)]** <Insert description>.

4. Exposed Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** <Insert material and finish>.
 5. Lockset: Tumbler type with separate lock and key for coin box.
- T. Sanitary-Napkin Disposal Unit <Insert drawing designation>:
1. Mounting: **[Recessed]** **[Partition mounted, dual access]**.
 2. Door or Cover: Self-closing, disposal-opening cover **[and hinged face panel with tumbler lockset]**.
 3. Receptacle: Removable.
 4. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** **[ABS plastic, gray]** <Insert material and finish>.
- U. Seat-Cover Dispenser <Insert drawing designation>:
1. Mounting: **[Surface mounted]** **[Recessed]** **[Partition mounted, dual access]**.
 2. Minimum Capacity: **[250]** **[500]** <Insert number> seat covers.
 3. Exposed Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** **[ABS plastic, gray]** <Insert material and finish>.
 4. Lockset: Tumbler type.
- V. Purse Shelf <Insert drawing designation>:
1. Description: **[Hinged unit with spring-loaded shelf that automatically returns to vertical position]** <Insert description>.
 2. Nominal Size: **[15 inches long by 5-1/2 inches wide]** <Insert dimensions>.
 3. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** **[Chrome-plated, cast-zinc alloy (zamac) with stippled finish on tray and bright chrome finish on edges]** <Insert material and finish>.
- W. Mirror Unit <Insert drawing designation>:
1. Frame: **[Stainless steel angle, 0.05 inch thick]** **[Stainless steel channel]** **[Stainless steel, fixed tilt]** **[Stainless steel, adjustable tilt]**.
 - a. Corners: **[Manufacturer's standard]** **[Mitered and mechanically interlocked]** **[Welded and ground smooth]**.
 2. Size: **[As indicated on Drawings]** <Insert dimensions>.
 3. Shelf:
 - a. Type: **[Integral, welded]** **[Concealed mounting]** **[Exposed mounting]**.
 - b. Depth: **[5 inches]** <Insert dimension>.

4. Hangers: [Manufacturer's standard rigid, tamper and theft resistant] <Insert requirements>.
- X. Hook <Insert drawing designation>:
1. Description: [Double-prong unit] [Single-prong unit] [Combination hat and coat hook] [Combination door bumper and coat hook] <Insert description>.
 2. Mounting: [Concealed] [Exposed].
 3. Material and Finish: [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
- Y. Fixed-Height Adult Changing Station <Insert drawing designation>:
1. Description: Horizontal unit that opens by folding down from stored position and with adjustable strap.
 - a. Engineered to support minimum of **[400 lb]** <Insert value> static load when opened.
 2. Mounting: [Surface mounted, with unit projecting not more than **4 inches** from wall when closed] [Semi-recessed, with unit projecting not more than **1 inch** from wall when closed].
 3. Operation: By pneumatic shock-absorbing mechanism.
 4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners] <Insert requirements>.
 5. Liner Dispenser: Provide **[built-in] [separate, locking]** dispenser for disposable sanitary liners.
- Z. Adjustable-Height Adult Changing Station <Insert drawing designation>:
1. Description: Height-adjustable horizontal unit that is electrically operated with wired hand control and with safety rail **[and receiver tray] [and receiver tray with integrated drain outlet]**.
 - a. Engineered to support minimum of **[300 lb] [350 lb] [400 lb]** <Insert value> static load when opened.
 2. Mounting: Surface mounted, foldable by pneumatic shock-absorbing mechanism.
 3. Electrical Characteristics: Manufacturer's standard actuator and control system, with integrated 24 V dc transformer, powered by single 120 V electrical receptacle.
 4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin), with PVC mattress] <Insert requirements>.
- 2.04 TOILET-COMPARTMENT OCCUPANCY-INDICATOR SYSTEM
- A. Toilet-Compartment Occupancy-Indicator System <Insert drawing designation>:

1. Description: Battery-powered latch and electrically powered indicator-light system. Latches communicate wirelessly with separate, overhead indicator lights.
2. Latch: Slide operation.
 - a. Compatibility: Provide latch compatible with compartment doors indicated for Project.
 - b. Power Source: Two AA batteries.
 - 1) Low-Battery Warning: Indicator light pulses when associated batteries of corresponding latch require replacement.
 - c. Patch Kit: Stainless steel in manufacturer's standard finish, adhesively applied to interior and exterior of compartment door to cover existing hardware locations.
 - d. Latch Material and Finish: Matte chrome-plated, die-cast zinc alloy (zamac); installed with stainless steel fasteners.
3. Indicator Light: Full-color, low-voltage, LED indicator that displays red when compartment door is latched, green when standard compartment door is unlatched, and blue when accessible compartment door is unlatched.
 - a. Traffic-Management-System Operation: Indicator lights also controlled by traffic management system for remote **[override of indicator light color] [and] [data collection from indicator lights]**.
 - b. Mounting: **[Ceiling, surface] [Ceiling, semi-recessed] [Ceiling, pendant] [Wall] mounted**.
 - c. Body Material and Finish: Satin white finish ABS plastic; installed with stainless steel fasteners.
 - d. Lens Material and Finish: **[Clear] [Frosted]** acrylic.
 - e. Electrical Requirements: Provide indicator lights with dc adapters and that allow up to 30 lights to be powered by single 115 V, 20 A, electrical receptacle.

2.05 PUBLIC-USE SHOWER ROOM ACCESSORIES

- A. Source Limitations: Obtain **[public-use shower room accessories] [each type of public-use shower room accessory]** from single source from single manufacturer.
- B. Shower Curtain Rod <Insert drawing designation>:
 1. Description: **[1-inch-] [1-1/4-inch-]** OD, straight rod.
 2. Configuration: **[As indicated on Drawings] <Insert description>**.
 3. Mounting Flanges: **[Exposed] [Concealed] <Insert requirements> fasteners; in [manufacturer's standard material and finish] [material and finish matching rod] <Insert requirements>**.
 4. Rod Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Polished chrome-plated brass] <Insert material and finish>**.
- C. Shower Curtain <Insert drawing designation>:
 1. Size: Minimum **[6 inches] [12 inches]** wider than opening by 72 inches high.

2. Material: [Vinyl, minimum **0.006 inch** thick, opaque, matte] [Duck, minimum **8 oz.**, white, 100 percent cotton] [Nylon-reinforced vinyl, minimum **9 oz.** or **0.008-inch-** thick vinyl, with integral antibacterial and flame-retardant agents] <Insert material>.
3. Color: [White] [Beige] [Green] [As selected from manufacturer's full range] <Insert color>.
4. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
5. Shower Curtain Hooks: [**Chrome-plated or stainless steel, spring wire curtain hooks with snap fasteners**] <Insert description>, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

D. Folding Shower Seat <Insert drawing designation>:

1. Configuration: [L-shaped seat, designed for wheelchair access] [Rectangular seat] [Triangular, corner-type seat] [Stainless steel seat designed to fold into recessed-mounted, stainless steel wall box] <Insert description>.
2. Seat: [Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect] [White vinyl padded seat] [Stainless steel, ASTM A480/A480M No. 4 finish (satin); **0.05-inch-** minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth] <Insert description>.
3. Mounting Mechanism: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert description>.
4. Dimensions: <Insert dimensions>.

E. Soap Dish <Insert drawing designation>:

1. Description: [**Recessed**] [**Surface**] mounted, with the following features:
 - a. Washcloth bar.
 - b. <Insert requirements>.
2. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] <Insert material and finish>.

F. Robe Hook <Insert drawing designation>:

1. Description: [**Double**] [**Single**]-prong unit.
2. Material and Finish: [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.

2.06 STAFF BATHROOM ACCESSORIES

- A. Source Limitations: Obtain [**staff bathroom accessories**] [**each type of staff bathroom accessory**] from single source from single manufacturer.
- B. Staff Toilet Tissue Dispenser <Insert drawing designation>:

1. Description: **[Single] [Double]**-roll dispenser with the following features:
 - a. Hood.
 - b. Multiple roll dispenser must be vertical stacked.
 - c. Do not use Jumbo-roll at accessible stalls or single user toilets.
 2. Mounting: **[Recessed] [Surface mounted]**.
 3. Capacity: Designed for 4-1/2 diameter tissue rolls.
 4. Material and Finish: **[Solid brass, polished] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)]** <Insert material and finish>.
- C. Staff Shower Curtain Rod **<Insert drawing designation>**:
1. Description: **[1-inch-] [1-1/4-inch-]** OD, **[straight] [curved]** rod.
 2. Configuration: **[As indicated on Drawings]** <Insert description>.
 3. Mounting Flanges: **[Exposed] [Concealed]** <Insert requirements> fasteners; in **[manufacturer's standard material and finish] [material and finish matching rod]** <Insert requirements>.
 4. Rod Material and Finish: **[Solid brass, polished] [Polished chrome-plated brass] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)]** <Insert material and finish>.
 5. Features: Integral chrome-plated brass glide hooks.
- D. Staff Folding Shower Seat **<Insert drawing designation>**:
1. Configuration: **[L-shaped seat, designed for wheelchair access] [Rectangular seat] [Triangular, corner-type seat] [Stainless steel seat designed to fold into recessed-mounted, stainless steel wall box]** <Insert description>.
 2. Seat: **[Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect] [White vinyl padded seat] [Stainless steel, ASTM A480/A480M No. 4 finish (satin); 0.05-inch- minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth]** <Insert description>.
 3. Mounting Mechanism: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** <Insert description>.
 4. Dimensions: <Insert dimensions>.
- E. Staff Soap Dish **<Insert drawing designation>**:
1. Description: <Insert description>.
 2. Mounting: **[Recessed] [Surface mounted]**.

3. Material and Finish: [Solid brass, polished] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.

F. Staff Medicine Cabinet <Insert drawing designation>:

1. Mounting: [Recessed, for nominal **4-inch** wall depth] [Surface mounted].
2. Size: [**18 by 24 inches**] <Insert dimensions>.
3. Door: [Framed mirror door concealing storage cabinet equipped with continuous hinge and spring-buffered, rod-type stop and magnetic door catch] <Insert description>.
4. Shelves: [Three, adjustable] <Insert requirements>.
5. Material and Finish:
 - a. Cabinet: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Steel with corrosion-resistant finish].
 - b. Mirror Frame: <Insert material and finish>.
 - c. Door: <Insert material and finish>.
 - d. Hinge: <Insert material and finish>.
 - e. Shelves: <Insert material and finish>.

G. Staff Facial Tissue Dispenser <Insert drawing designation>:

1. Mounting: [Recessed] [Surface mounted] <Insert requirements>.
2. Depth: [**2-5/8 inches**] [**4 inches**] <Insert dimension>.
3. Material and Finish:
 - a. Dispenser Face: [Polished chrome-plated brass] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated steel] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
 - b. Cabinet: [Steel with corrosion-resistant finish] <Insert material and finish>.

H. Staff Robe Hook <Insert drawing designation>:

1. Description: [**Double**] [**Single**]-prong unit.
2. Material and Finish: [Solid brass, polished] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.

I. Staff Toothbrush and Tumbler Holder <Insert drawing designation>:

1. Description: <Insert description>.

2. Material and Finish: [Solid brass, polished] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
- J. Staff Towel Bar <Insert drawing designation>:
1. Description: [**3/4-inch-** square tube with rectangular end brackets] [**3/4-inch-** round tube with circular end brackets] <Insert description>.
 2. Mounting: Flanges with [**concealed**] [**exposed**] fasteners.
 3. Length: [**18 inches**] [**24 inches**] [**30 inches**] <Insert dimension>.
 4. Material and Finish: [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] [Polished aluminum] <Insert material and finish>.
- K. Staff Towel Pin <Insert drawing designation>:
1. Description: Projecting minimum of [**3 inches**] [**5 inches**] <Insert dimension> from wall surface.
 2. Material and Finish: [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
- L. Staff Towel Ring <Insert drawing designation>:
1. Description: Pin projecting approximately [**2-1/2 inches**] <Insert dimension> from wall with [square] [circular] [oval] [trapezoidal] <Insert requirements> ring.
 2. Pin Material and Finish: [Solid brass, polished] [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated brass] [Polished chrome-plated zinc alloy (zamac)] [Stainless steel, ASTM A480/A480M No. 4 finish (satin)] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
 3. Ring Material and Finish: [Matching pin] [Clear plastic] <Insert requirements>.
- M. Staff Towel Shelf <Insert drawing designation>:
1. Description: Surface-mounted, guest-towel shelf with [**four**] <Insert number> stainless steel tubes, [**3/8 inch in diameter**] [**5/16 inch square**] <Insert requirements>, mounted in support arms.
 - a. towel Bar: [**1/4-inch- diameter**] [**5/16-inch- square**] stainless steel towel bar below shelf.
 2. Length: [**18 inches**] [**24 inches**] <Insert dimension>.
 3. Material and Finish: [Polished brass-plated, stainless steel] [Polished chrome-plated, stainless steel] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
- N. Staff Towel Rack <Insert drawing designation>:

1. Description: [Surface-mounted, guest-towel unit with approximately **1/4-inch-** diameter wire rings welded to upright wire bracket] <Insert description>.
 2. Capacity: [**Two**] [**Three**] [**Four**] <Insert number> sets of bath towels, hand towels, and washcloths.
 3. Nominal Height: [**11 inches**] [**17 inches**] [**21 inches**] <Insert dimension>.
 4. Material and Finish: [Polished brass-plated zinc alloy (zamac)] [Polished chrome-plated zinc alloy (zamac)] <Insert material and finish>.
- O. Staff Retractable Clothesline <Insert drawing designation>:
1. Description: Surface-mounted [**rectangular**] [**circular**] housing with minimum 72-inch-long, retractable, spring-actuated, synthetic clothesline and remote retention bracket.
 2. Material and Finish [Chrome-plated brass] [Stainless steel, ASTM A480/A480M No. 7 finish (polished)] <Insert material and finish>.
- 2.07 HEALTHCARE ACCESSORIES
- A. Source Limitations: Obtain [**healthcare accessories**] [**each type of healthcare accessory**] from single source from single manufacturer.
- B. Specimen Pass-Through Cabinet with u shaped pull. <Insert drawing designation>:
1. Description: [Two-sided type, with self-closing, interlocking doors on both sides, that prevent both from being open at same time, and removable stainless steel tray] [Turntable type, with minimum **12-inch-** diameter removable cylinder that revolves on stainless steel, self-lubricating, ball-bearing plates; with over-rotation prevention mechanism] <Insert description>.
 2. Nominal Wall Opening: [**12 by 11-1/4 inches**] [**13-1/4 by 14 inches**] <Insert dimensions>, width by height.
 3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 4. Lockset: Tumbler type.
- C. Bedpan and Urinal Cabinet <Insert drawing designation>:
1. Description: [for storing one conventional-size bedpan and one urinal bottle; with door that produces **1/2-inch** opening at top and bottom of cabinet to allow air circulation] <Insert requirements>.
 2. Mounting: Recessed.
 3. Nominal Wall Opening: [**13-1/2 by 26-1/2 by 5 inches**] <Insert dimensions>, width by height by depth.
 4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- D. Bedpan Rack <Insert drawing designation>:

1. Description: for storing [one conventional-size bedpan] [two conventional-size bedpans].
2. Mounting: Surface mounted.
3. Size: [12 by 11 inches] [12 by 27 inches] <Insert dimensions>, width by height.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

E. Bedpan and Urinal Rack <Insert drawing designation>:

1. Description: for storing one conventional-size bedpan and one urinal bottle.
2. Mounting: Surface mounted.
3. Size: [12 by 27 inches] <Insert dimensions>, width by height.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.08 CHILDCARE ACCESSORIES

A. Source Limitations: Obtain [childcare accessories] [each type of childcare accessory] from single source from single manufacturer.

B. Diaper-Changing Station <Insert drawing designation>:

1. Description: [Horizontal] [Vertical] unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of [250 lb] <Insert value> static load when opened.
2. Mounting: [Surface mounted, with unit projecting not more than 4 inches from wall when closed] [Semi-recessed, with unit projecting not more than 1 inch from wall when closed].
3. Operation: By pneumatic shock-absorbing mechanism.
4. Material and Finish: [HDPE in manufacturer's standard color] [HDPE with plastic-laminate insert in color selected by Architect] [Stainless steel, ASTM A480/A480M No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners] [Stainless steel, ASTM A480/A480M No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color] <Insert requirements>.
5. Liner Dispenser: Provide [built-in] [separate, locking] dispenser for disposable sanitary liners.

C. Diaper-Changing Station Liner Dispenser <Insert drawing designation>:

1. Mounting: Recessed.
2. Minimum Capacity: [100] <Insert number> liners.

3. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** <Insert material and finish>.
4. Lockset: Tumbler type.
5. Accessible lever or push controls.

D. Diaper-Pack Vendor <Insert drawing designation>:

1. Mounting: **[Surface mounted] [Recessed]**.
2. Minimum Capacity: **[24]** <Insert number> diaper packs.
3. Coin Operation: Coin slot preset for **[one U.S. dollar, adjustable up in 25-cent increments]** <Insert requirements>.
4. Material and Finish: **[Stainless steel, ASTM A480/A480M No. 4 finish (satin)]** <Insert material and finish>.
5. Accessible lever or push controls.

E. Child-Protection Seat <Insert drawing designation>:

1. Description: Unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of **[80 lb] [150 lb]** <Insert value> static load when opened.
2. Mounting: Surface mounted, with unit projecting not more than **[4-1/2 inches] [6 inches]** from wall when closed.
3. Material and Finish: **[HDPE in manufacturer's standard color]** <Insert requirements>.

2.09 UNDERLAVATORY GUARDS

A. Underlavatory Guard <Insert drawing designation>:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.10 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain **[custodial accessories] [each type of custodial accessory]** from single source from single manufacturer.

B. Custodial Utility Shelf <Insert drawing designation>:

1. Description: with exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
2. Size: **[16 inches long by 6 inches deep]** <Insert dimensions>.

3. Material and Finish: Not less than nominal 0.05-inch- thick stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Custodial Mop and Broom Holder <Insert drawing designation>:

1. Description: [Unit with shelf, hooks, holders, and rod suspended beneath shelf] <Insert description>.
2. Length: [36 inches] <Insert dimension>.
3. Hooks: [Four] <Insert number>.
4. Mop/Broom Holders: [Three] <Insert number>, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
 - b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.11 HAND-SANITIZER DISPENSERS

- A. Source Limitations: Obtain [hand-sanitizer dispensers] [each type of hand-sanitizer dispenser] from single source from single manufacturer.

B. Hand-Sanitizer Dispenser <Insert drawing designation>:

1. Description: Manually operated dispenser [with drip tray,] designed for dispensing alcohol-based hand rub in [gel] [foam] form. Designed to not release contents unless manually activated and to not dispense more hand rub than the amount required for hand hygiene consistent with label instructions.
2. Mounting: Wall mounted.
 - a. Protrusion Limit: Installed unit protrudes maximum 4 inches from wall surface.
3. Capacity: [24 oz.] [34 oz.] [41 oz.] [68 oz.] <Insert value> maximum.
4. Materials: [ABS plastic, white] [ABS plastic, black] [ABS plastic, dark gray] <Insert requirements>.
5. Lockset: Tumbler type.
6. Refill Indicator: [Window type] [Translucent top] [Translucent bottom].

C. Automatic Hand-Sanitizer Dispenser <Insert drawing designation>:

1. Description: Automatic, battery powered dispenser with [drip tray, and] infrared sensor designed to detect presence of hands and dispense alcohol-based hand rub in [gel] [foam] form. Designed to not release contents unless activated and to not dispense more hand rub than the amount required for hand hygiene consistent with label instructions. Designed for activation to only occur when an object is placed within 4 inches of sensing device and so that an object placed and left within the activation zone will not cause more than one activation.
2. Mounting: [Wall mounted] [Floor stand].

- a. Protrusion Limit: Installed unit protrudes maximum 4 inches from wall surface.
3. Capacity: **[34 oz.] [41 oz.]** <Insert value> maximum.
4. Materials: **[ABS plastic, white] [ABS plastic, black] [ABS plastic, dark gray]** <Insert requirements>.
5. Refill Indicator: **[LED indicator] [Window type] [Translucent top] [Translucent bottom]**.
6. Low-Battery Indicator: LED indicator.

2.12 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.13 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of **[six] <Insert number>** keys to Owner's representative.

PART 3 EXECUTION

3.01 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F446.
- C. Shower Seats: Install to comply with specified structural-performance requirements.

3.03 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 10 41 16

EMERGENCY ACCESS KEY BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes Fire department emergency access key boxes.

1.02 SUBMITTALS

- A. Manufacturer Product Data for the key vaults.
- B. Closeout: A minimum of 4 tagged keys the Owner.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Companies specializing in manufacturing emergency access key boxes with minimum 20 years documented experience.
- B. Installer: Company specializing in installation of emergency access key boxes with minimum 3 documented experience.

1.04 REGULATORY REQUIREMENTS

- A. Comply with requirements of CFC Section 506.

PART 2 PRODUCTS

2.01 EMERGENCY ACCESS KEY BOXES

- A. 3200 Series, keyed lock, complying with UL 1037 and UL listed by Knox Co., or equal.
 - 1. Configurations: Recess mounted.
 - 2. Capacity: Up to 10 keys, access cards and other small items necessary for emergency access.
 - 3. Box sizes: To be verified with the Fire Marshall.
 - 4. Components:
 - a. 1/4-inch solid steel housing, 100 percent welded, colors as indicated on the Drawings.
 - b. 1/2-inch solid plate steel door with gasket and stainless steel door hinge.
 - c. 1/8-inch thick stainless steel lock cover.
 - d. Lock: double-action rotating tumblers and hardened steel pins accessed by biased cut key.
 - e. Finish: Manufacturer's proprietary finishing process; "Dark Bronze" color.
 - 1) Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

- 2) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- 3) Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.

3.02 INSTALLATION

- A. Install emergency access key box in accordance with Fire Department requirements and with manufacturer's instructions and recommendations.
- B. Isolate surfaces that will be in contact with plaster with foam tape.
- C. Install vaults in compliance with their manufacturer's instructions and recommendations plumb, level and secure to their supports.
- D. Emergency Access Key Boxes: Install emergency access key boxes with centerline not more than 48 inches above finished floor.

3.03 FIELD QUALITY CONTROL

- A. Examine and test emergency access key boxes.

3.04 ADJUSTING AND CLEANING

- A. Remove protective cover, where applicable, and clean.
- B. Verify proper operation of locks and hinges.
- C. Touchup damaged finishes, where the results are acceptable to the Architect, otherwise replace with new components.
- D. On completion of emergency access key boxes installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION

SECTION 10 43 21

ACCESSIBILITY EVACUATION CHAIRS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes providing accessibility evacuation chairs.

1.02 SUBMITTALS

- A. Product data, for the chair.
- B. Provide training video for future use instruction.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.04 WARRANTY

- A. The manufacturer shall warrant the chair against defects and material failure for 15 years after Certificate of Occupancy is issued.

PART 2 PRODUCTS

2.01 ACCESSIBILITY EVACUATION CHAIR

- A. Manufacturers:
 - 1. Basis of Design: Evacu-Track Emergency Evacuation Chair by Garaventa Lift.
 - 2. Or equal.
- B. Capacity: 400 lbs.
- C. Decent Speed: 3.6 feet/second with hydraulic speed governor.
- D. Weight of chair: 48 lbs.
- E. Chair to have the following characteristics:
 - 1. Auxiliary wheels for movement on flat surfaces.
 - 2. Head restraint system.
 - 3. Adjustable velcro straps to secure the individual in the chair.
 - 4. Failsafe braking system that allows unit to stop and hold a fully loaded chair on the stair.
 - 5. Fold compact when not in use.

2.02 ACCESSORIES

- A. Provide sheet metal storage cabinet for each chair.
 - 1. Include graphic to clearly identify contents.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine adjacent construction and supports.
- B. Verify that openings are properly framed, within allowable tolerances, plumb, level, clean, will provide a solid anchoring surface.
- C. Correct detrimental conditions proceeding with installation.

3.02 INSTALLATION

- A. Install cabinet plumb, level, and square with adjacent construction.
- B. Attach securely to substrate.

3.03 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chair.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes portable, **[hand-carried]** **[wheeled]** fire extinguishers **[and mounting brackets for fire extinguishers]**.
- B. Owner-Furnished Material: **[Hand-carried]** **[Wheeled]** fire extinguishers.
- C. Related Requirements:
 - 1. Section 104413 "Fire Protection Cabinets."
 - 2. Section 233813 "Commercial-Kitchen Hoods" for fire-extinguishing systems provided as part of commercial-kitchen exhaust hoods.

1.02 ALLOWANCES

- A. Fire Extinguishers are part of **<Insert name of allowance>**.

1.03 UNIT PRICES

- A. Work of this Section is affected by **<Insert name of unit price>**.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.
 - 1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher **[and mounting brackets]**.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. **[Use same designations indicated on Drawings.]**

1.06 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.08 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: **[Six]** <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each **[fire-protection cabinet]** **[and]** **[mounting bracket]** indicated.
 - 1. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
 - 2. Valves: **[Manufacturer's standard]** **[Nickel-plated, polished-brass body]**.
 - 3. Handles and Levers: **[Manufacturer's standard]** **[Stainless steel]**.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B **[**, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging**]**.
- B. Stored-Pressure Water Type <Insert drawing designation>: UL-rated 2-A, 2.5-gal. nominal capacity, with water in stainless steel container; with pressure-indicating gage.
- C. Stored-Pressure Antifreeze Water Type <Insert drawing designation>: UL-rated 2-A, 2.5-gal. nominal capacity, with water and approved antifreeze solution mixed for temperatures as low as minus 40 deg F in stainless steel container; with pressure-indicating gage.
- D. Stored-Pressure Water-Mist Type <Insert drawing designation>: UL-rated 2-A:C, 2.5-gal. nominal capacity, with water in enameled-steel container; with pressure-indicating gage.

- E. Pressurized, AFFF-Foam Type <Insert drawing designation>: UL-rated **[2-A:10-B, 1.6-gal.] [3-A:20-B, 2.5-gal.]** nominal capacity, with AFFF foam in stainless steel container; with pressure-indicating gage.
- F. Pressurized, FFFP-Foam Type <Insert drawing designation>: UL-rated 3-A:20-B, 2.5-gal. nominal capacity, with FFFP foam in stainless steel container; with pressure-indicating gage.
- G. Wet-Chemical Type <Insert drawing designation>: UL-rated 2-A:1-B:C:K, **[1.6-gal.] [2.5-gal.]** nominal capacity, with potassium **[acetate] [citrate] [carbonate]**-based chemical in stainless steel container; with pressure-indicating gage.
- H. Regular Dry-Chemical Type <Insert drawing designation>: UL-rated <Insert capacity> nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.
- I. Regular Dry-Chemical Type in Steel Container <Insert drawing designation>: UL-rated **[2-B:C, 1-lb] [10-B:C, 2.5-lb] [10-B:C, 5-lb] [40-B:C, 5.5-lb] [40-B:C, 6-lb] [60-B:C, 10-lb] [120-B:C, 20-lb]** nominal capacity, with sodium bicarbonate-based dry chemical in enameled-steel container.
- J. Regular Dry-Chemical Type in Aluminum Container <Insert drawing designation>: UL-rated **[2-B:C, 1-lb] [10-B:C, 2.5-lb] [10-B:C, 5-lb] [40-B:C, 5.5-lb] [60-B:C, 10-lb] [120-B:C, 20-lb]** nominal capacity, with sodium bicarbonate-based dry chemical in enameled-aluminum container.
- K. Regular Dry-Chemical Type in Brass Container <Insert drawing designation>: UL-rated **[40-B:C, 6-lb] [60-B:C, 10-lb] [120-B:C, 20-lb]** nominal capacity, with sodium bicarbonate-based dry chemical in chrome-plated-brass container.
- L. Multipurpose Dry-Chemical Type <Insert drawing designation>: UL-rated <Insert capacity> nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.
- M. Multipurpose Dry-Chemical Type in Steel Container <Insert drawing designation>: UL-rated **[1-A:10-B:C, 2.5-lb] [2-A:10-B:C, 5-lb] [3-A:40-B:C, 5-lb] [3-A:40-B:C, 6-lb] [4-A:60-B:C, 10-lb] [10-A:120-B:C, 20-lb]** nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
- N. Multipurpose Dry-Chemical Type in Aluminum Container <Insert drawing designation>: UL-rated **[1-A:10-B:C, 2.5-lb] [2-A:10-B:C, 5-lb] [3-A:40-B:C, 5-lb] [3-A:40-B:C, 6-lb] [4-A:60-B:C, 10-lb] [10-A:120-B:C, 20-lb]** nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.
- O. Multipurpose Dry-Chemical Type in Brass Container <Insert drawing designation>: UL-rated **[2-A:10-B:C, 5-lb] [3-A:40-B:C, 6-lb] [4-A:60-B:C, 10-lb] [4-A:80-B:C, 10-lb] [10-A:120-B:C, 20-lb]** nominal capacity, with monoammonium phosphate-based dry chemical in chrome-plated-brass container.
- P. Purple-K Dry-Chemical Type in Aluminum Container <Insert drawing designation>: UL-rated **[10-B:C, 2.5-lb] [30-B:C, 5-lb] [120-B:C, 20-lb]** nominal capacity, with potassium bicarbonate-based dry chemical in enameled-aluminum container.
- Q. Purple-K Dry-Chemical Type in Brass Container <Insert drawing designation>: UL-rated **[80-B:C, 10-lb] [120-B:C, 20-lb]** nominal capacity, with potassium bicarbonate-based dry chemical in chrome-plated-brass container.

- R. Carbon Dioxide Type <Insert drawing designation>: UL-rated **[5-B:C, 5-lb]** **[10-B:C, 10-lb]** **[10-B:C, 15-lb]** **[10-B:C, 20-lb]** nominal capacity, with carbon dioxide in **[manufacturer's standard enameled-metal]** **[enameled-steel]** **[enameled-aluminum]** container.
- S. Dry-Powder Type <Insert drawing designation>: **[FM approved,]**UL-rated Class D, 30-lb nominal capacity, with **[sodium chloride]** **[copper]**-based powder in enameled-steel container; with pressure-indicating gage.
- T. Halon Type <Insert drawing designation>: **[5-B:C, 2.5-lb]** **[10-B:C, 5-lb]** nominal capacity, in enameled-steel container; with pressure-indicating gage.
1. UL-rated.
- U. Clean-Agent Type in Aluminum Container <Insert drawing designation>: UL-rated **[1-B:C, 1.4-lb]** **[2-B:C, 2.5-lb]** **[5-B:C, 5-lb]** nominal capacity, with HCFC Blend B agent and inert material in enameled-aluminum container; with pressure-indicating gage.
- V. Clean-Agent Type in Brass Container <Insert drawing designation>: UL-rated **[1-A:10-B:C, 11-lb]** **[2-A:10-B:C, 15.5-lb]** nominal capacity, with HCFC Blend B agent and inert material in chrome-plated-brass container; with pressure-indicating gage.
- W. Clean-Agent Type in Steel Container <Insert drawing designation>: UL-rated **[5-B:C, 4.75-lb]** **[1-A:10-B:C, 10-lb]** **[2-A:10-B:C, 14-lb]** nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.
- 2.03 MOUNTING BRACKETS <Insert drawing designation>
- A. Mounting Brackets: Manufacturer's standard **[galvanized]** steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or **[red]** **[black]** baked-enamel finish.
1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Horizontal.
- 2.04 WHEELED FIRE EXTINGUISHERS <Insert drawing designation>
- A. Wheeled Fire Extinguishers: Type, size, and capacity for locations indicated, complete with carriage.
- B. Source Limitations: Obtain wheeled fire extinguishers and fire extinguishers from single source from single manufacturer.
1. Carriage: Fabricated from enameled-steel pipe, complete with hanger assembly, long-range nozzle, hose, and **[semipneumatic solid-rubber tires]** **[wide-rim wheels]**.
 - a. Hose: **[15 feet]** **[50 feet]** **[100 feet]**.
- C. Pressurized, FFFP-Foam Type: UL-rated 20-A:160-B, 33-gal. nominal capacity, with FFFP foam in stainless steel container.

- D. Regular Dry-Chemical Type: UL-rated **[160-B:C, 50-lb]** **[240-B:C, 150-lb]** **[160-B:C, 250-lb]** nominal capacity, with sodium bicarbonate-based dry chemical in **[regulated]** **[stored]** **[direct]**-pressure, enameled-steel container.
- E. Multipurpose Dry-Chemical Type: UL-rated **[20-A:160-B:C, 30-lb]** **[30-A:160-B:C, 50-lb]** **[40-A:240-B:C, 125-lb]** **[40-A:160-B:C, 250-lb]** nominal capacity, with monoammonium phosphate-based dry chemical in **[regulated]** **[stored]** **[direct]**-pressure, enameled- **[steel]** **[aluminum]** **[steel or -aluminum]** container.
- F. Purple-K Dry-Chemical Type: UL-rated **[160-B:C, 50-lb]** **[320-B:C, 125-lb]** **[160-B:C, 250-lb]** nominal capacity, with potassium bicarbonate-based dry chemical in **[regulated]** **[stored]** **[direct]**-pressure, enameled-steel container.
- G. Carbon Dioxide Type: UL-rated **[20-B:C, 50-lb]** **[20-B:C, 100-lb]** nominal capacity, with carbon dioxide in **[manufacturer's standard enameled-metal]** **[enameled-steel]** **[enameled-aluminum]** container.
- H. Dry-Powder Type: **[FM approved,]**UL-rated Class D, **[sodium chloride-based powder, 150-lb]** **[copper-based powder, 250-lb]** nominal capacity, in regulated-pressure, enameled-steel container; with pressure-indicating gage.
- I. Clean-Agent Type: UL-rated **[4-A:40-B:C, 65-lb]** **[10-A:80-B:C, 150-lb]** nominal capacity, with HCFC Blend B agent and inert material in stored-pressure, enameled-steel container; with pressure-indicating gage.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fire extinguishers **[and mounting brackets]** in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
 - 1. Mounting Height: Top of fire extinguisher to be at **[42 inches]** **<Insert dimension>** above finished floor.

END OF SECTION

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SECTION 10 51 13

METAL LOCKERS, BENCHES AND CUBBIES

PART 1 - GENERAL

1.01 SUMMARY

A. Principal work in this Section:

1. Single or [] tier welded corridor metal lockers with sloped tops.
2. Locker benches.
3. Metal cubbies.
4. Supplementary parts and components, such as inserts, clips, fasteners, anchors, closure pieces, and other miscellaneous supports and accessories required for a complete installation.
5. Obtain locker size, number of tiers, features and design from College Building User Group (BUG) and sign of by the Department Chair or his/her representative.

1.02 DEFINITIONS

- A. Cubbies are defined as welded, open-front lockers, fabricated similar to welded corridor metal lockers.

1.03 SUBMITTALS

- A. Data: Submit copies of manufacturer specifications giving sizes, materials, finishes, roughing-in diagrams and installation instructions.
- B. Shop drawings:
1. Submit dimensioned shop drawings show locker layout at each location.
 2. Elevation of each locker bank and benches.
 3. Drawings of benches including attachment details.
 4. Show attachment and anchoring details with size of anchors to be used.
- C. Samples: Submit locker manufacturer's color chips.

1.04 QUALITY ASSURANCE

- A. Provide all lockers, benches and cubbies for the Project made by the same manufacturer.

1.05 HANDLING

- A. Procedure: In accordance with the manufacturer's recommendations.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers and cubbies that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Damage from deliberate destruction and vandalism is excluded.
- B. Warranty Period for welded metal lockers and cubbies: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain metal lockers [, locker benches,] [, cubbies] and accessories from single source from single locker manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers [, cubbies] [and locker benches] indicated to be accessible, comply with applicable provisions in [the DOJ's "2010 ADA Standards for Accessible Design"] [the ABA standards of the Federal agency having jurisdiction] [and] [ICC A117.1] <Insert requirement>.

2.03 MANUFACTURER

- A. Manufacturer: One of the following.
 - 1. Vanguard Lockers by Penco.
 - 2. Standard Corridor Lockers by Republic Storage Products.
 - 3. Emperor Lockers by Hadrian Inc.
 - 4. Standard School Lockers by Lyon.
 - 5. Or equal.
- B. MATERIALS AND COMPONENTS
 - 1. Type: Manufacturer's standard and ADA compliant, single tier clothes lockers sized
 - 2. _____wide x ___tall x ___deep. Provide latch and locking hardware that does not require twisting, pinching or grasping to operate. Provide shelf and pole placed a few inches below the ADA maximum so that the items on the shelf can be reached.
 - 3. Material: Mild, cold-rolled, stretcher-leveled furniture steel free of surface imperfections and capable of taking a high grade baked enamel finish.
 - 4. Body: Manufacturer's standard construction, as follow.
 - a. 24 gage back, top and bottom.
 - b. Tops, bottoms shall be flanged on all sides; backs flanged on 2 sides.
 - c. Upright shall be offset at the front and flanged at the rear to provide a double lapped rear corner.
 - d. Bolts and nuts shall be zinc plated.

- C. Doors:
1. 18 gage steel (minimum) flanged on all sides for stiffness and reinforced as required to prevent racking and deformation.
 2. Provide stamped louvers at the top and bottom of each door.
- D. Hinges:
1. 2 in. high, 5-knuckle, full loop type, welded, or attached with tamper-proof fasteners, to both locker frame and door.
 2. Provide 2 hinges for each door.
 3. Hinge doors in the direction shown on the Drawings.
- E. Lock: Positive automatic pre-locking type, so that the locker may be locked while door is open, then closed without unlocking and without damaging locking mechanism. Lock shall not require twisting, pinching or grasping to operate.
- F. Latching:
1. Provide latch hardware that does not require twisting, pinching, or grasping to operate.
 2. One-piece, pre-lubricated, self-contained spring steel latch, completely contained within the lock bar under tension to provide rattle-free operation and latching at 2 points in the frame.
 3. The lock bar shall be of pre-painted, double-channel steel construction held laterally in the door channel by non-removable self-formed retainers, pierced from the door.
 4. Provide provision for padlocking.
- G. Locker Benches:
1. Provide bench units with overall assembly height of [17-1/2 inches (445 mm)] <Insert dimension>.
 2. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 - a. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick) [except provide 20- to 24-inch- (508- to 610-mm-) wide tops where accessible benches are indicated].
 - b. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
 - c. Extruded aluminum with clear anodic finish.
 3. Fixed-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors.
 4. Movable-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top, complete with fasteners.
- H. Handle: Sturdy zinc die cast material.
1. Attached fixed case to the door with screws or bolts and a shock absorbing stud.
 2. The case must fully shield the lifting trigger from below.
 3. The lifting trigger shall have 2 right angle lugs that insert into the lock bar.
 4. Equip lifting trigger shall with rubber silencers at top and bottom to prevent metal- to-metal contact.

5. Make Padlock attachment through 3/8 in. diameter hole position.

I. Number Plate:

1. Polished aluminum plate with black numerals not less than ½ in. high.
2. Number as directed by the District.
3. Attach plates to exterior of doors with pop rivets.

2.04 FABRICATION

- A. Fabricate components straight, clean cut and free from dents, scratches, oil-canning, pitting, seam marks, roller marks, trade names and roughness and other defects.
- B. Remove blemishes by grinding before cleaning, treating and applying specified finishes.
- C. Provide necessary cut-outs and reinforcement for hardware.
- D. Welded Construction: Factory preassemble metal lockers and cubbies by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.
- E. Accessible Lockers and cubbies: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- F. Finishing:
1. Hardware: Heavy chrome-plating with a mirror finish (US 26), and polished aluminum for number plates.
 2. All other Ferrous Surfaces: Clean, phosphatize and seal, apply enamel finish coat and bake under controlled conditions. Color shall be one of the manufacturer's standards with a 55 to 60 sheen, as selected by the Architect.

PART 3 - EXECUTION

A. INSTALLATION

1. Install lockers and cubbies plumb, level and secure in compliance with their manufacturer's recommendations and Building Code seismic regulations. Conceal fasteners wherever possible.
2. Welded Lockers and cubbies: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.
3. Install trim to provide flush, hairline joints against adjacent construction. Adjust doors and hardware to operate freely without binding.
4. Touch-up minor damage or replace damaged parts. Replace lockers and cubbies damaged beyond satisfactory field repair, as determined by the Architect, at no cost to the District.

5. Fixed Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.
6. Movable Benches: Place benches in locations indicated on Drawings.

B. ADJUSTING

1. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. [Verify that integral locking devices operate properly.]

END OF SECTION

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SECTION 10 56 13
METAL STORAGE SHELVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Case-type metal storage shelving.
2. Four-post metal storage shelving.
3. Post-and-beam metal storage shelving.

B. Related Requirements:

1. Section 11 40 00 "Foodservice Equipment" for metal shelving in kitchen, pantry, and refrigerated spaces.
2. Section 11 51 23 "Library Stack Systems" for library shelving systems including cantilever-bracket shelving supported by wall-mounted standards.
3. Section 12 35 53.13 "Metal Laboratory Casework" for metal shelving in laboratories.
4. Section 12 35 70 "Healthcare Casework" for metal shelving in central sterile supply rooms, clean utility rooms, and similar spaces for the storage of medical instruments and supplies.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance for **[Case-Type]** [and] **[Four-Post]** Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.1.
- C. Structural Performance for Post-and-Beam Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.2.
- D. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]** <Insert requirement>.
 1. Seismic Component Importance Factor: **[1.5]** **[1.0]**.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.
- B. Shop Drawings: For customized metal storage shelving. Include plans, elevations, sections, details, and attachments to other work. Include installation details of connectors, lateral bracing, and special bracing.

- C. Samples for Initial Selection: For units with factory-applied color finishes. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For the following components, of size indicated below:
 - 1. Vertical **[End Panels] [Posts]**: 12 inches tall.
 - 2. Shelves: Full size, but not more than 24 inches wide by 12 inches deep.
 - 3. Connectors for **[Shelf to End Panel] [Shelf to Post] [Beam to Post]**: Full size.
 - 4. Shelf-Label Holders: Full size.
- E. Product Schedule: For metal storage shelving. **[Use same designations indicated on Drawings.]**
- F. Delegated-Design Submittal: For metal storage shelving indicated to comply with performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for seismic restraints.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified **[Installer] [professional engineer]**.
- B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of metal storage shelving from manufacturer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.06 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Shelves: Full-size units equal to **[5] <Insert number>** percent of amount installed for each type indicated, but no fewer than **[five] <Insert number>** shelves.
 - 2. Shelf-to-Post Connectors: Full-size units equal to **[5] <Insert number>** percent of amount installed for each type indicated, but no fewer than **[10] <Insert number>** connectors.
 - 3. Shelf-Label Holders: Full-size units equal to **[5] <Insert number>** percent of amount installed for each type indicated, but no fewer than **[10] <Insert number>** holders.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal storage shelving from single source from single manufacturer.
- C. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

- A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.
- B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with G60zinc (galvanized) or A60zinc-iron-alloy (galvannealed) coating.
- D. Steel Tubing: ASTM A 513, Type 2.
- E. Stainless-Steel Tubing: ASTM A 554, Grade MT-304.
- F. Steel Wire: ASTM A 899.
- G. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
- H. Particleboard: ANSI A208.1 [, made with binder containing no urea formaldehyde].
- I. Hardboard: ANSI A135.4.
- J. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- K. Floor Anchors: Galvanized-steel, **[post-installed expansion anchors]**, **[power-actuated fasteners]**, **[or] [threaded concrete screws]**. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.
- L. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide **[one] <Insert number>** per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.02 CASE-TYPE METAL STORAGE SHELVING <Insert drawing designation>

- A. General: Factory-formed, field-assembled, freestanding, case-type metal storage shelving system, designed for shelves to span between and be supported by sheet metal end panels (without posts), with shelves adjustable over the height of shelving unit. Fabricate shelf units with end panel at each end so each unit is independent. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Metal Shelving Storage by UNICOR or approved Equal product.
- B. Load-Carrying Capacity per Shelf: **[200 lb]** [As indicated on Drawings] <Insert load>.
- C. End Panels: Fabricated from cold-rolled steel sheet, with concealed perforations at front and back edges at **[manufacturer's standard spacing] [1 inch o.c.]** for receiving adjustable shelf clips.
1. Steel-Sheet Thickness, Nominal: **[0.036 inch]** [As required for load-carrying capacity per shelf and number of shelves] <Insert thickness>.
 2. Adjustable Shelf Clips: Fabricated from **[0.036-inch-]** <Insert thickness> nominal thickness, cold-rolled steel; with projections designed to engage at least two perforations in end panels.
- D. End Panels: Fabricated from cold-rolled steel sheet; with horizontal slots spaced at **[manufacturer's standard spacing] [1 inch o.c.] [1-1/2 inches o.c.]** for supporting shelves.
1. Steel-Sheet Thickness, Nominal: **[0.036 inch]** [As required for load-carrying capacity per shelf and number of shelves] <Insert thickness>.
- E. Back Panel: One piece, fabricated from cold-rolled steel sheet.
1. Steel-Sheet Thickness, Nominal: **[0.036 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
- F. Shelves: Fabricated from cold-rolled steel sheet **[, with slots or holes at 2 inches o.c. for shelf dividers]**. Fabricate shelves with vertical front that is flanged and returned.
1. Steel-Sheet Thickness, Nominal: **[0.048 inch]** [As required for load-carrying capacity per shelf and number of shelves] <Insert thickness>.
- G. Shelf Quantity: **[Three] [Four] [Five] [Six]** <Insert number> shelves per shelving unit in addition to top and bottom shelf.
- H. Base: Closed front, with base strips fabricated from same material and with same finish as end panels.
- I. Overall Unit Width: **[30 inches] [36 inches] [42 inches] [48 inches]** <Insert dimension>.
- J. Overall Unit Depth: **[12 inches] [18 inches] [24 inches]** <Insert dimension>.
- K. Overall Unit Height: **[72 inches] [84 inches] [96 inches]** <Insert dimension>.
- L. Accessories:

1. Finished End Panels: Fabricated as **[solid] [perforated]** <Insert description> full-height panels from same material and with same finish as end panels, with trim for a finished appearance along edges abutting end panels and top shelf.
2. Shelf Dividers: Fabricated from same material and with same finish as shelves; **[full-height] [angle] [tapered] [sliding]** <Insert description> type.
3. Bins: Fabricated from same material and with same finish as shelves; **[size as indicated on Drawings]** <Insert dimensions>.
4. Shelf-Label Holders: **[Clear] [Colored]** plastic, designed to clip onto front edge of shelf.

M. Finish: **[Baked enamel] [or] [powder coat]**.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

2.03 FOUR-POST METAL STORAGE SHELVING

A. **[Open] [Closed]** Four-Post Metal Storage Shelving <Insert drawing designation>: Factory-formed, field-assembled, freestanding system, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units **[similarly, so each unit is independent] [as add-on units, designed to share two corner posts with initial shelving unit]**. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, **[provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Four-Post Metal Shelving by UNICOR or approved Equal product.
3. Load-Carrying Capacity per Shelf: **[350 lbs.] [700 lbs.] [1500 lbs.]** [As indicated on Drawings] <Insert load>.
4. Posts: Fabricated from hot-rolled steel; in **[angle] [offset angle] [beaded] [T-] [tubular T-] [V-] [box] [manufacturer's standard]** shape; with perforations at 1-1/2 inches o.c. to receive shelf-to-post connectors.
 - a. Steel Thickness, Nominal: **[0.075 inch]** [As required for load-carrying capacity per shelf and number of shelves] <Insert thickness>.
 - b. Add-On Shelf Posts: Fabricated from hot-rolled steel, **[T-] [manufacturer's standard]** <Insert shape> shape; perforated to match main posts and of same thickness.
 - c. Post Base: **[Bolt leveler] [Adjustable steel floor plate, drilled for floor anchors]**.
5. Bracing: Manufacturer's standard, **[single] [or] [double]** diagonal cross bracing at **[back] [and] [ends]**; as required for stability, load-carrying capacity of shelves, and number of shelves.
6. Back Panel: **[One piece] [Two half panels]** fabricated from cold-rolled steel sheet.
 - a. Steel-Sheet Thickness, Nominal: **[0.024 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
7. End Panels: Fabricated from cold-rolled steel sheet.

- a. Steel-Sheet Thickness, Nominal: **[0.024 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
8. Solid-Type Shelves: Fabricated from steel sheet as follows:
 - a. Steel-Sheet Thickness, Nominal: **[0.030 inch]** **[0.036 inch]** **[0.048 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
 - b. Metallic-Coated Steel-Sheet Thickness, Nominal: **[0.034 inch]** **[0.040 inch]** **[0.052 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
 - c. Slots or Holes for Shelf Dividers: **[2 inches]** **[3 inches]** <Insert dimension> o.c.
 - d. Fabricate fronts and backs of shelves with box-formed edges, with corners lapped and welded.
 - e. Fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel **[bars]**, **[angles]**, [or] **[channels]**.
9. Framed-Type Wire Shelves: **[Steel]** **[Metallic-coated-steel]** wire; with shelf frame fabricated from same material and with same finish as posts.
10. Truss-Type Wire Shelves: **[Steel]** **[Metallic-coated-steel]** **[Stainless-steel]** **[Manufacturer's standard, chrome-plated]** wire-over-wire construction, with downturned wire truss edges.
11. Shelf Quantity: **[Three]** **[Four]** **[Five]** **[Six]** <Insert number> shelves per shelving unit in addition to top and bottom shelf.
12. Shelf-to-Post Connectors: **[Mechanical fasteners (nuts and bolts)]** **[Compression clips]** **[Support clips]** **[Containment clips]** **[Horizontal supports with rivet connectors to post]** **[Manufacturer's standard connectors]** <Insert type>.
13. Base: **[Open, with exposed post legs]** **[Closed, with base strips fabricated from same material and with same finish as shelving]**.
14. Overall Unit Width: **[30 inches]** **[36 inches]** **[42 inches]** **[48 inches]** <Insert dimension>.
15. Overall Unit Depth: **[12 inches]** **[18 inches]** **[24 inches]** <Insert dimension>.
16. Overall Unit Height: **[72 inches]** **[84 inches]** **[96 inches]** <Insert dimension>.
17. Accessories:
 - a. Finished End Panels: Fabricated as **[solid]** **[perforated]** <Insert description> full-height panels from manufacturer's standard thickness cold-rolled steel sheet and with same finish as posts, with trim for a finished appearance along edges abutting posts and top shelf.
 - b. Shelf Dividers: Fabricated from same material and with same finish as shelves; **[full-height]** **[angle]** **[tapered]** **[sliding]** <Insert description> type.
 - c. Bins: Fabricated from same material and with same finish as shelves; **[size as indicated on Drawings]** <Insert dimensions>.
 - d. Shelf-Label Holders: **[Clear]** **[Colored]** plastic, designed to clip onto front edge of shelf.
18. Finish: **[Baked enamel]** [or] **[powder coat]**.
 - a. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

- B. Wire-Type, Four-Post Metal Storage Shelving <Insert drawing designation>: Factory-formed, field-assembled, freestanding system without back or end panels, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units **[similarly, so each unit is independent] [as add-on units, designed to share two corner posts with initial shelving unit]**. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Wire-Type, Four-Post Metal Shelving by UNICOR or approved Equal product.
 3. Load-Carrying Capacity per Shelf: **[200 lb] [600 lb] [1200 lb]** [As indicated on Drawings] <Insert load>.
 4. Posts: Fabricated from 1-inch-OD, **[square] [round]** tubing of indicated material; with grooves or notches at 1 inch o.c. to receive shelf-to-post connectors. Label posts with numbers at not less than 2 inches o.c. for determining shelf height.
 - a. Post Material: **[Steel] [Stainless steel]**.
 - b. Post Base: **[Bolt leveler] [Adjustable steel floor plate, drilled for floor anchors]**.
 - c. Post Cap: Nylon or plastic.
 5. Framed-Type Wire Shelves: **[Steel] [Metallic-coated-steel] [Stainless-steel]** wire-over-wire construction, with shelf frame fabricated from same material and with same finish as posts; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
 6. Truss-Type Wire Shelves: **[Steel] [Metallic-coated-steel] [Stainless-steel] [Manufacturer's standard, chrome-plated]** wire-over-wire construction, with downturned wire truss edges; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
 7. Waterfall-Type Wire Shelves: **[Steel] [Metallic-coated-steel] [Stainless-steel]** wire-over-wire waterfall construction; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
 8. Solid-Type Shelves: Fabricated from 0.050-inch-thick, stainless-steel sheet metal of indicated material and thickness.
 9. Shelf Quantity: **[Three] [Four] [Five] [Six]** <Insert number> shelves per shelving unit in addition to top and bottom shelf.
 10. Shelf-to-Post Connectors: Manufacturer's standard one-piece collet (wedge), designed to engage post collar attached to shelves.
 11. Bracing: Manufacturer's standard diagonal cross bracing, as required for stability, load-carrying capacity of shelves, and number of shelves.
 12. Overall Unit Width: **[24 inches] [36 inches] [48 inches] [60 inches]** <Insert dimension>.
 13. Overall Unit Depth: **[12 inches] [18 inches] [24 inches]** <Insert dimension>.
 14. Overall Unit Height: **[60 inches] [72 inches] [84 inches]** <Insert dimension>.
 15. Accessories:

- a. Shelf Dividers: Fabricated from same material and with same finish as shelves; **[full-height] [angle] [tapered] [sliding]** <Insert description> type.
 - b. Shelf Inlay: Manufacturer's standard **[clear plastic] [static-dissipative plastic] [hardboard]** <Insert material> mat.
 - c. Storage Basket: Edge-of-shelf-mounted wire basket, <Insert dimensions>; fabricated from same material and with same finish as shelves.
 - d. Back Ledges: **[1 inch] [4 inches]** <Insert dimension> high, fabricated from same material and with same finish as shelves.
 - e. Side Ledges: **[1 inch] [4 inches]** <Insert dimension> high, fabricated from same material and with same finish as shelves.
 - f. Garment Hanger Tube: Width of **[21 inches] [shelves]** <Insert dimension>; with mounting brackets.
 - g. Shelf-Label Holders: **[Clear plastic] [Colored plastic] [Cold-rolled steel sheet]**, designed to clip onto front edge of shelf.
16. Steel Finish: **[Baked enamel], [powder coat], [or] [Manufacturer's standard chrome plated]**.
- a. Color and Gloss: **[As indicated by manufacturer's designations] [Match University Representative's sample] [As selected by University Representative from manufacturer's full range]** <Insert color and gloss>.
17. Stainless-Steel Finish: **[No. 4 directional-satin finish] [Manufacturer's standard non-directional-polish finish]**.

2.04 POST-AND-BEAM METAL STORAGE SHELVING <Insert drawing designation>

- A. General: Factory-formed, field-assembled, freestanding, post-and-beam metal storage shelving system, designed for shelves to be supported by beams that span between and are supported by corner posts, with beams adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units **[similarly, so each unit is independent] [as add-on units, designed to share two corner posts with initial shelving unit]**. Provide fixed top and bottom beams, adjustable intermediate beams, and accessories indicated.
- 1. Manufacturers: Subject to compliance with requirements, **[provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, Provide Post -And-Beam Metal Shelving by UNICOR or approved Equal product.
- B. Load-Carrying Capacity per Shelf: **[400 lbs.] [1000 lbs.] [2000 lbs.]** [As indicated on Drawings] <Insert load>.
- C. Posts: Fabricated from cold-rolled steel; in **[manufacturer's standard] [manufacturer's standard angle or open-box] [1-1/2-by-1-1/2-inch angle] [open-box]** shape; with perforations at 1-1/2 inches o.c. to receive beam-to-post connectors.
- 1. Steel Thickness, Nominal: **[0.075 inch]** [As required for load-carrying capacity per shelf and number of shelves] <Insert thickness>.
 - 2. Add-On Shelf Posts: Fabricated from hot-rolled steel, T-shape; perforated to match main posts and of same thickness.
 - 3. Post Base: Cold-rolled steel floor plate, drilled for floor anchors.

- D. Beams: Fabricated from cold-rolled steel; in **[channel] [flanged] [channel or flanged] [manufacturer's standard]** shape; with projecting **[rivet] [tab] [manufacturer's standard]** beam-to-post connectors at each end designed to engage posts. Provide beam at each side of each shelf, with center supports as required for load-carrying capacity of shelf.
1. Steel Thickness, Nominal: **[0.075 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
 2. Provide top, bottom, and intermediate shelf beams with **[single] [double]** beam-to-post connectors.
 3. Provide top and bottom shelf beams with double beam-to-post connectors and intermediate shelf beams with single beam-to-post connectors.
 4. Provide beams for the number of shelves required.
 5. Provide beams for <Insert number> shelves per shelving unit in addition to top and bottom shelf beams.
- E. Particleboard Shelves: 5/8 inch thick; **[factory] [or] [field]** cut.
- F. Flat Metal Shelves: Fabricated from steel sheet as follows:
1. Steel-Sheet Thickness, Nominal: **[0.030 inch] [0.036 inch] [0.048 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
 2. Metallic-Coated Steel-Sheet Thickness, Nominal: **[0.034 inch] [0.040 inch] [0.052 inch]** [As required for load-carrying capacity per shelf] <Insert thickness>.
 3. Fabricate **[fronts and backs] [fronts, backs, and sides]** of shelves with box-formed edges, with corners lapped and welded.
- G. Ribbed-Metal-Decking Shelves: Fabricated from **[0.036-inch-] <Insert thickness>** nominal thickness steel sheet.
- H. Wire Shelves: Welded steel wire; with **[2-by-4-inch]** [Manufacturer's standard] <Insert dimensions> openings.
- I. Shelf Quantity: **[Three] [Four] [Five] [Six]** <Insert number> shelves per shelving unit in addition to top and bottom shelf.
- J. Overall Unit Width: **[36 inches] [48 inches] [60 inches] [69 inches] [72 inches] [96 inches]** <Insert dimension>.
- K. Overall Unit Depth: **[18 inches] [24 inches] [30 inches] [36 inches] [48 inches]** <Insert dimension>.
- L. Overall Unit Height: **[60 inches] [72 inches] [84 inches] [96 inches]** <Insert dimension>.
- M. Accessories:
1. Tie Plates: Cold-rolled steel, finished to match posts; designed for joining posts of adjacent shelving units.
 2. Supports: **[Back-to-wall]** [and] **[back-to-back]** type that bolt to posts; as required for shelving unit stability.
 3. Record Boxes: Knocked-down, corrugated fiberboard with white finish and contrasting contents legend; with pre-punched handles and matching separate lid.

- a. Letter/Legal-Size Boxes: 12-1/2 inches wide by 16 inches deep by 10-1/2 inches high for letter-size material stored left to right and legal-size material stored front to back.
 - 1) Quantity: <Insert number>.
 - b. Letter-Size Boxes: 12-1/2 inches wide by 24 inches deep by 10-1/2 inches high for letter-size material stored left to right.
 - 1) Quantity: <Insert number>.
4. Record Box Support Rails: 1-1/2-by-1-1/2-inch metal angle, with length to match depth of shelving unit; fabricated from same material and with same finish as beams.
- N. Finish: [Baked enamel] [or] [powder coat].
1. Color and Gloss: [As indicated by manufacturer's designations] [Match University Representative's sample] [As selected by University Representative from manufacturer's full range] <Insert color and gloss>.

2.05 FABRICATION

- A. Shop Fabrication: Prefabricate shelving components in shop to greatest extent possible to minimize field fabrication; temporarily preassemble shelving components where necessary to ensure that field-assembled components fit together properly. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate metal storage shelving square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
1. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
 2. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 3. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
 4. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.
- C. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work. **[Form backs of shelving units up to 48 inches wide from one piece.]**
- D. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a 1/2-inch-wide hem on the concealed side; ease edges of metal plate to radius of approximately 1/32 inch. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

2.06 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 METALLIC-COATED STEEL-SHEET FINISHES

- A. Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

2.08 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" or SSPC-SP 8, "Pickling."
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

2.09 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: No. 4.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine floors for suitable conditions where metal storage shelving will be installed.
- C. Examine **[walls]** **[and]** **[ceilings]** to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Vacuum finished floor **[and wet mop resilient flooring]** over which metal storage shelving is to be installed.

3.03 INSTALLATION

- A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
 3. Adjust post-base bolt leveler to achieve level and plumb installation.
 4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
 5. Install seismic restraints.
 6. Connect **[side-to-side]** **[and]** **[back-to-back]** shelving units together.
 7. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.
 - a. Case-Type Metal Storage Shelving: Install adjustable shelf clips at front and back of each shelf.
 - b. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.
 - c. Post-and-Beam Metal Storage Shelving: Install beams with beam-to-post connectors fully engaged in post perforations.
- B. Accessories:
1. Install finished end panels and trim at exposed ends of shelving units.
 2. Shelf Dividers: Install <Insert number> **[full-height dividers per shelf]** **[angle dividers per shelf]** **[tapered dividers per shelf]** **[sliding dividers per shelf]** **[dividers of types and locations indicated on Drawings]**.
 3. Bins: Install **[<Insert number> per shelf]** **[at locations indicated on Drawings]**.
 4. Shelf-Label Holders: Install **[one]** **<Insert number>** on each shelf, **[centered]** **[vertically aligned]** **[at locations indicated on Drawings]** within each shelving unit.
 5. Record Box Support Rails: Provide two for each record storage box.
 6. Shelf Inlays: Install **[one per shelf]** **[at locations indicated on Drawings]**.
 7. Storage Baskets: Install **[<Insert number> per shelf]** **[at locations indicated on Drawings]**.
 8. Back Ledges: Install **[one per shelf]** **[at locations indicated on Drawings]**.
 9. Side Ledges: Install **[on each side of each shelf]** **[at locations indicated on Drawings]**.
 10. Garment Hanger Tubes: Install **[one per shelving unit]** **[<Insert number> where directed]** **[at locations indicated on Drawings]**.

3.04 ERECTION TOLERANCES

- A. Erect **[case-type]** [and] **[four-post]** metal storage shelving to a maximum tolerance from vertical of 1/2 inch in up to 10 feet of height, not exceeding 1 inch for heights taller than 10 feet.
- B. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of 1/4 inch in 84 inches of height.

3.05 ADJUSTING

- A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.
- B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
- C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- D. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 10 73 33

MARQUEES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Field-lettered signs painted directly on substrates in good condition.
 - 2. Wall-identification signs for fire and smoke assemblies.
- B. Related Requirements:
 - 1. Section 10 14 00 for signage and wayfinding.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show sign locations and mounting heights.
 - 2. Show message list, typestyles, graphic elements, and layout for each sign at least [half size] <Insert scale>.
- C. Samples: For each type of paint, paint system, color, and gloss; [minimum 4 inches (100 mm) long in least dimension] <Insert dimensions>; on hardboard.
 - 1. Label each Sample for location and application.
 - 2. Program Requirements

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Image Specifications:
 - 1. If within 50' of closest viewers (e.g. by sidewalk):
 - a. 8mm Pixel pitch (spacing)
 - b. 8500NIT SMD/8mm pixel pitch (distance between pixels)
 - 2. If beyond 50' Distant from all viewers (e.g. LASC field from highway):
 - a. 10,000NIT discrete LED/10mm pixel pitch
 - 3. 160 degree horizontal/70 degree vertical image viewing

4. One controller per screen so that two sided screens can show different images (e.g. "Turn left at____, on one side, "Turn Right at____" on the other). Each display to be able to show a unique image
 5. Automatic brightness control with hundreds of variations and auto-night dimming
 6. 20-bit color, capable of producing Quintillian + color variations
 7. Refresh rate capable of at least 8000Hz, and adjustable downward to 3840Hz
 8. Automatic image scaling if various sizes of Marquees are on system so that image looks best for each Marquee
 9. Still and motion capability 60FPS minimum
 10. 208V preferred, 120V acceptable so long as manufacturer agrees it is suitable for the model offered
- B. Software:
1. Cloud software to upload by web login.
 2. Dual authentication required.
 3. 24x7x365 login.
- C. Component Requirements:
1. IP67/IP65 LED/SMD module front/back water rating.
 2. IP54 cabinet back water rating.
 3. 100,000 hour expected life of LEDs/SMDs.
 4. Fan-less power supplies with $\geq 400,000$ hour expected life.
 5. Highly weather-resistant finishes.
- D. Service:
1. 5 year extended on-site warranty (if manufacturer warranty does not already include this or more).
 2. All warranty service on-site.
 3. Resolution within 3 days for most issues.
 4. Factory service personnel if possible.
 5. Easy-to-replace components: Front-service modules.
 6. Remote diagnostics with service alerts received by Campus and Manufacturer covering Tile, power, data, media player and providing automatic email alerts for automatic warranty action.
 7. Response pro-actively triggered when alerts merit.
 8. Parts availability guarantee 10 years.
 9. Manufacturer to include listing of components by manufacturer and part number with ordering information.
 10. Manufacturer to include service manual detailing how to check and change components.
 11. Manufacturer to provide support for software platform changes and connectivity changes (e.g. cellular to fiber decision or change from proprietary software provided to future digital signage software standard of LACCD)

- E. Media delivery:
 - 1. Option 1: Cellular pre-paid by manufacturer for full term of warranty (advantage: no traffic on, or access to, Campus network).
 - 2. Option 2: Direct SM fiber.
 - 3. Regardless of option, manufacturer is to include fiber adapter and agree to support transition to/from one option to the other during the full warranty period.
- F. Contract terms:
 - 1. Lifetime software upgrades and support of college change in software (e.g. due to digital signage/emergency systems).
 - 2. Manufacturer supports (billable, but supported) future changes:
 - a. Conversion to premise media delivery via fiber if College elects.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance. Comply with paint manufacturer's written instructions for inspection.
- B. If existing surfaces cannot be prepared to an acceptable condition for proper painting, notify Architect in writing.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surface is dry.
- D. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 INSTALLATION

- A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.03 ADJUSTING AND CLEANING

- 1. Remove and reapply damaged or deformed signs and signs that do not comply with specified requirements. Reapply signs with damaged or deteriorated finishes that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- 2. After completing sign application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
4. Remove temporary protective coverings and strippable films as signs are installed.
5. Insert a sign schedule here or on Drawings to list each sign type by drawing designation, text, and quantity, coordinated with Drawings. Also include sign size, font, colors, and locations to the extent that these items are not shown on Drawings. See Evaluations for an example of a sign schedule.

END OF SECTION

SECTION 10 75 16
GROUND-SET FLAGPOLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes ground-set flagpoles made from **[aluminum] [copper alloy (bronze)] [stainless steel] [steel] [and] [fiberglass]**.
- B. Owner-Furnished Material: Flags.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For each flagpole.
 - 1. Include the following
 - a. Plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
 - b. Section, and details of foundation system.
- C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.
- D. Delegated Design Submittals: For flagpoles.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design flagpole assemblies.
- B. Seismic Performance: Flagpole assemblies to withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]** <Insert requirement>.
- C. Structural Performance: Flagpole assemblies, including anchorages and supports, to withstand design loads indicated within limits and under conditions indicated.
 - 1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location is <Insert wind speed>.
 - 2. Base flagpole design on **[polyester]** **[nylon or cotton]** flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.03 ALUMINUM FLAGPOLES

- A. Aluminum Flagpoles: **[Cone]** **[Entasis]**-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B241/B241M, Alloy 6063, with a minimum wall thickness of 3/16 inch.
- B. Exposed Height: **[20 feet]** **[25 feet]** **[30 feet]** **[35 feet]** **[40 feet]** **[45 feet]** **[50 feet]** **[60 feet]** **[70 feet]** **[80 feet]** <Insert dimension>.
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
 - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
 - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
 - 1. Flashing Collar: Same material and finish as flagpole.
- E. Sleeve for Aluminum Flagpole: **[Fiberglass]** **[or]** **[PVC pipe]** foundation sleeve, made to fit flagpole, for casting into concrete foundation.
 - 1. Flashing Collar: Same material and finish as flagpole.
- F. Cast-Metal Shoe Base: Made from aluminum **[with same finish and color as flagpoles]** <Insert finish and color> for anchor-bolt mounting; furnish with anchor bolts.
 - 1. Furnish ground spike.
- G. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.
 - 1. Finish: Same as flagpole.
 - 2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
 - 3. Furnish ground spike.

- H. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Furnish tilting flagpole with steel counterweight box and weights, or furnish with internal counterweight. Furnish base with anchor bolts.
1. Finish: Same as flagpole.
 2. Furnish ground spike.

2.04 COPPER-ALLOY (BRONZE) FLAGPOLES

- A. Copper-Alloy (Bronze) Flagpoles: **[Cone] [Entasis]**-tapered flagpoles fabricated from seamless pipe or tube complying with ASTM B43 or ASTM B135, Alloy UNS C23000 (red brass, 85 percent copper).
- B. Exposed Height: **[20 feet] [25 feet] [30 feet] [35 feet] [40 feet] [45 feet] [50 feet] [60 feet] [70 feet] [80 feet]** <Insert dimension>.
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
1. Flashing Collar: Same material and finish as flagpole.
- E. Cast-Metal Shoe Base: Made from steel **[with finish matching flagpole]** <Insert finish and color> for anchor-bolt mounting; furnish with anchor bolts.
1. Furnish ground spike.

2.05 STAINLESS STEEL FLAGPOLES

- A. Stainless Steel Flagpoles: **[Cone] [Entasis]**-tapered flagpoles fabricated from pipe, tube, or plate complying with ASTM A312/A312M, ASTM A269, or ASTM A666, **[Type 304] [Type 316L]**.
- B. Exposed Height: **[20 feet] [25 feet] [30 feet] [35 feet] [40 feet] [45 feet] [50 feet] [60 feet] [70 feet] [80 feet]** <Insert dimension>.
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
1. Flashing Collar: Same material and finish as flagpole.

- E. Cast-Metal Shoe Base: Made from steel **[with finish matching flagpole]** <Insert finish and color> for anchor-bolt mounting; furnish with anchor bolts.

1. Furnish ground spike.

2.06 STEEL FLAGPOLES

- A. Steel Flagpoles: **[Cone-tapered]** **[Stepped-sectional]** flagpoles fabricated from standard-weight, seamless steel pipe complying with ASTM A53/A53M, Type S, Grade B, or steel tube complying with ASTM A513.

- B. Exposed Height: **[20 feet]** **[25 feet]** **[30 feet]** **[35 feet]** **[40 feet]** **[45 feet]** **[50 feet]** **[60 feet]** **[70 feet]** **[80 feet]** <Insert dimension>.

- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.

2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

3. Provide self-aligning, snug-fitting joints.

- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

1. Flashing Collar: Same material and finish as flagpole.

2. Furnish steel ground protectors extending 12 inches aboveground and 6 inches belowground for steel flagpoles where flashing collars are not provided.

- E. Cast-Metal Shoe Base: Made from steel **[with finish matching flagpole]** <Insert finish and color> for anchor-bolt mounting; furnish with anchor bolts.

1. Furnish ground spike.

2.07 FIBERGLASS FLAGPOLES

- A. Fiberglass Flagpoles: **[Cone]** **[Entasis]**-tapered flagpoles fabricated from polyester resin reinforced with woven glass-fiber roving with 75 percent of glass fibers parallel to length of flagpole.

- B. Exposed Height: **[20 feet]** **[25 feet]** **[30 feet]** **[35 feet]** **[40 feet]** **[45 feet]** **[50 feet]** **[60 feet]** **[70 feet]** **[80 feet]** <Insert dimension>.

- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.

2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

- D. Sleeve for Fiberglass Flagpole: **[Fiberglass]** **[or]** **[PVC pipe]** foundation sleeve, made to fit flagpole, for casting into concrete foundation.

1. Flashing Collar: Same material and finish as flagpole.

- E. Cast-Metal Shoe Base: Made from aluminum **[with finish matching flagpole]** <Insert finish and color> for anchor-bolt mounting; furnish with anchor bolts.
 - 1. Furnish ground spike.
- F. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.
 - 1. Finish: Same as flagpole.
 - 2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
 - 3. Furnish ground spike.

2.08 FITTINGS

- A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
 - 1. 0.063-inch spun aluminum [, finished to match flagpole] [with gold anodic finish].
 - 2. 20-oz. copper with 23-karat, gold-leaf finish.
 - 3. Spun stainless steel, finished to match flagpole.
 - 4. Spun copper alloy, finished to match flagpole.
- B. Finial Eagle: Sized [as indicated] [as standard with manufacturer for flagpole size indicated] <Insert size>.
 - 1. Cast aluminum [, finished to match flagpole] [with gold anodic finish].
 - 2. 20-oz. copper with 23-karat, gold-leaf finish.
- C. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
 - 1. Halyard Flag Snaps: [Chromium-plated bronze] [Stainless steel] [Bronze] [Nylon] swivel snap hooks [with neoprene or vinyl covers]. Furnish two per halyard.
 - 2. Plastic Halyard Flag Clips for Internal Halyard, Winch System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.
- D. Internal Halyard, Cam Cleat System: **[5/16-inch-diameter, braided polypropylene]** <Insert type> halyard; cam cleat; and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
 - 1. Halyard Flag Snaps: [Chromium-plated bronze] [Stainless steel] [Bronze] [Nylon] swivel snap hooks [with neoprene or vinyl covers]. Furnish two per halyard.
 - 2. Plastic Halyard Flag Clips for Internal Halyard, Cam Cleat System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

- E. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous **[5/16-inch-diameter, braided polypropylene halyard]** <Insert type> and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
1. Halyards and Cleats: **[One]** **[Two]** at each flagpole.
 2. Cleat Covers: Cast metal, finished to match flagpole, secured with cylinder locks.
 3. Halyard Covers: 2-inch channel, 60 inches long, finished to match flagpole.
 4. Halyard Flag Snaps: **[Chromium-plated bronze]** **[Stainless steel]** **[Bronze]** **[Nylon]** swivel snap hooks **[with neoprene or vinyl covers]**. Furnish two per halyard.
 5. Plastic Halyard Flag Clips for External Halyard, Ball-Bearing System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

2.09 MISCELLANEOUS MATERIALS

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.
- B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
- C. Sand: ASTM C33/C33M, fine aggregate.
- D. Elastomeric Joint Sealant: **[Multicomponent nonsag urethane]** **[Single-component nonsag urethane]** **[Single-component neutral-curing silicone]** joint sealant complying with requirements in Section 07 92 00 "Joint Sealants."
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.010 ALUMINUM FINISHES

- A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.
- B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41]** **[AA-M12C22A31]**.
- C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44]** **[AA-M12C22A32/A34]**.
1. Color: **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[As indicated by manufacturer's designation]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Gold Anodic Finish: AAMA 611, AA-M32C22A43; gold color.
- E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

- F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **[Insert color and gloss]**.

2.011 COPPER-ALLOY FINISHES

- A. Hand-Rubbed Finish, Lacquered: Directionally textured, fine satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil.
- B. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.
1. Color: Match Architect's sample.
 2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.012 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 2. Directional Satin Finish: No. 4.

2.013 STEEL FINISHES

- A. Flagpole Interior Finish: Apply one coat of bituminous paint on interior of flagpole.
- B. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A123/A123M.
- C. Polyurethane Enamel Finish: Remove mill scale and rust, if present, from uncoated steel, complying with **[SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning"]** **[or]** **[SSPC-SP 8, "Pickling"]** **[Insert surface preparation method]**. After cleaning, apply manufacturer's standard primer and two-coat, high-gloss, high-build, polyurethane-enamel finish.
1. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **[Insert color]**.
- D. Baked-Enamel or Powder-Coat Finish: Remove mill scale and rust, if present, from uncoated steel, complying with **[SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning"]** **[or]** **[SSPC-SP 8, "Pickling"]** **[Insert surface preparation method]**. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **[Insert color and gloss]**.

2.014 FIBERGLASS FINISHES

- A. Fiberglass: UV-light stable, hard, high-gloss gel coat or high-gloss, high-build polyurethane or polyester coating.
 - 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.
- F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to reinforcement.
- G. Place concrete, as specified in Section 03 30 00 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.02 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where indicated and according to [**Shop Drawings and**] manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION

SECTION 10 81 13
BIRD CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Bird control system.

1.02 PRE-INSTALLATION MEETING

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 SUBMITTALS

- A. Data: Manufacturer's data for bird control system, including standard details
- B. Shop Drawings: Provide shop drawing showing proposed custom installation details, and layout plans.
- C. Sample: 24-inch piece of the base/rod strip specified.

1.04 HANDLING

- A. Procedure: In accordance with Division One.

1.05 WARRANTY

- A. Warrant bird control system against defective materials and workmanship for 5 years following Substantial Completion.

PART 2 PRODUCT

2.01 MANUFACTURER

- A. Birdwire by Bird Barrier Co. (310.793.1733.)
- B. Bird Be Gone
- C. Or equal, with snap-off sections.

2.02 MATERIALS

- A. Birdwire posts, springs, brackets, clamps
- B. Material: 316 Stainless Steel
- C. Height: Rods available 3.5", 4.5", 5.5", 6.5" and 8"
- D. Birdwire: 325 ft, 975 ft, 1625 ft.

PART 3 EXECUTION

3.01 EXAMINATION/COORDINATION

- A. Verify conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.
- C. Coordinate installation of the bird control system with the work of related trades.

3.02 INSTALLATION

- A. Attach the system where indicated, straight, securely attached to supports, all in accordance with its manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

- A. Visually inspect installed bird barrier system for loose wires, fasteners and cracked or broken base sections.
- B. Replace damaged components to the satisfaction of the Architect.

END OF SECTION

DIVISION 11

EQUIPMENT

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SECTION 11 12 00
PARKING CONTROL EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Automatic barrier gates.
2. Vehicle detectors.
3. Traffic controllers.
4. Entry terminals.
5. Exit terminals.
6. Pay stations.
7. Fee computers.
8. Miscellaneous parking control equipment.
9. Parking facility management software.
10. Access control units.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for pipe bollards to protect parking control equipment.
2. Section 13 34 23.16 "Fabricated Control Booths" for cashiers'/parking attendants' booths.
3. Section 28 13 00 "Access Control Software and Database Management" for integrating parking control equipment with building access control.
4. Section 28 15 00 "Access Control Hardware Devices" for parking control equipment access devices.
5. Section 28 31 00 "Intrusion Detection" for integrating parking control equipment with the building intrusion detection system.

6. Section 28 31 21 "Area and Perimeter Intrusion Detection" for integrating parking control equipment with the site security control system.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
 1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
 2. Verify that equipment operation is consistent with system description.
 3. Review sequence of operation for each type of parking control equipment.
 4. Review coordination of interlocked equipment specified in this Section and elsewhere.
 5. Review required testing, inspecting, and certifying procedures.
 6. <Insert requirement>.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for parking control equipment.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties.
- B. Shop Drawings: For parking control equipment.
 1. Include plans, elevations, sections and attachment details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
 4. Vehicle Detectors: Layout and method of placement of vehicle loop detector system.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches square in size.
- D. Samples for Initial Selection: For units with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish 6 inches square in size.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On [USB media] [and] [approved online or cloud solution].
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Gate Arms: **[Two]** <Insert number> breakaway gate arms for each gate installed, complete with accessory components.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Parking Control System: For the following types of parking management:
 - 1. Transient Parking: Hourly rated parking, with fee paid while **[entering]** **[exiting]**.
 - 2. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
 - 3. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
 - 4. Flat-Rate or Hourly Parking: Fee paid at central pay station after parking.
 - 5. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
 - 6. Limited Date and Time Parking: Limited-duration parking, with predetermined fee access control card.
 - 7. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.

8. Valet Parking: Assisted parking, with fee paid while entering or exiting.
 9. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.
- B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 SOURCE LIMITATIONS

- A. Obtain **[parking control equipment]** <Insert equipment> from single source from single manufacturer.

2.03 AUTOMATIC BARRIER GATES <Insert drawing designation>

- A. General: Provide parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than 35 inches above pavement.

1. Standards: Barrier gate operators that are listed and labeled according to UL 325 by a qualified testing agency.

- B. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections. **[Noncommunicating]** **[Communicating]** type.

1. Noncommunicating Type:

- a. Capable of logic for one- and two-way lanes.
- b. Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.

2. Communicating Type:

- a. Real-time communication of lane counts, status messages, and execute commands.
- b. Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
- c. Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.
- d. Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling **[ticket dispensers]** **[card readers]** **[barcode imagers]** **[license plate recognition]** **[automatic vehicle identification]**.

3. Physical Characteristics:

- a. On-off power supply switch.
- b. Automatic-manual switch.
- c. Differential counter.
- d. Communication port.

- e. Internal **[resettable]** **[non-resettable]** counters.
 - f. Thermal-overload protection with manual reset.
 - g. Plug-in connectors for **[two]** **[three]** vehicle loop detectors.
 - h. Thermostatically controlled heater with on/off/auto switch.
 - i. Thermostatically controlled fan with on/off/auto switch.
 - j. Switch to test motor and limit switches.
 - k. Emergency manual disconnect.
 - l. Battery backup.
 - m. **[Single]** **[Two]** **[Four]**, 115-V ac grounded power receptacle.
4. Operational Characteristics:
- a. Able to store successive inputs and sequentially processing each one.
 - b. Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a zero- to 60-second, variable-time reset device.
 - c. Directional arming logic.
 - d. Broken gate-arm monitoring.
 - e. Programmable **[automatic]** timer.
 - f. Diagnostic mode for on-site testing **[, with LEDs for inputs and outputs]**.
 - g. Automatic and continuous testing of inputs and outputs.
 - h. Reversible arm capability for right- or left-handed operation.
- C. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall. Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish **[two]** **<Insert number>** keys for each lock **[, all locks keyed alike]**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
- 1. Steel Sheet: Not less than 0.097-inch-thick **[, galvanized-]** steel sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** **<Insert color>** baked-enamel or powder-coat finish.
 - 2. Aluminum Sheet: Not less than 0.125-inch-thick, aluminum sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** **<Insert color>** baked-enamel or powder-coat finish.
 - 3. Stainless-Steel Sheet: Not less than 0.109-inch-thick, stainless-steel sheet.
 - a. Finish cabinet exterior with No. 4 finish.
- D. Straight Gate Arm: **[1-by-4-inch nominal-size pine or redwood]** **[0.097-inch-thick steel]** **[Fiberglass, PVC, or polycarbonate]** **[Aluminum]**.

1. Traffic-Side Face: [Reflective painted finish and black diagonal stripes] [Reflective painted finish and red diagonal stripes] [Reflective painted finish and black and yellow diagonal stripes] [Manufacturer's standard finish and striping].
 2. Length: [10 feet] [12 feet] [As indicated on Drawings] <Insert length>.
 3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.
- E. Folding Gate Arm: Two pieces of 1-by-4-inch nominal-size pine or redwood joined together with metal side brackets.
1. Traffic-Side Face: [Reflective painted finish and black diagonal stripes] [Reflective painted finish and red diagonal stripes] [Reflective painted finish and black and yellow diagonal stripes] [Manufacturer's standard finish and striping].
 2. Length: [10 feet] [12 feet] [As indicated on Drawings] <Insert length>.
 3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.
- F. Straight Gate Arm with Counterbalance: 1-by-6-inch nominal-size pine or redwood with steel counterweights.
1. Traffic-Side Face: [Reflective painted finish and black diagonal stripes] [Reflective painted finish and red diagonal stripes] [Reflective painted finish and black and yellow diagonal stripes] [Manufacturer's standard finish and striping].
 2. Length: [16 feet] [As indicated on Drawings] <Insert length>.
 3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.
- G. Wishbone-Style Gate Arm: [1-by-4-inch nominal-size pine or redwood] [0.097-inch-thick steel] formed into wishbone configuration, with steel counterweights.
1. Traffic-Side Face: [Reflective painted finish and black diagonal stripes] [Reflective painted finish and red diagonal stripes] [Reflective painted finish and black and yellow diagonal stripes] [Manufacturer's standard finish and striping].
 2. Length: [14 feet] [As indicated on Drawings] <Insert length>.
 3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.
- H. Operator: UL labeled and listed, [Class I] [Class II] [Class III] [Class IV]. [1/3] [1/2] hp; <Insert number>-V, 60-Hz, single-phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through the speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.
1. Opening Time: [Three] [Six] <Insert number> seconds.
 2. Inherently adjustable, torque limiting clutch for safety.

I. Characteristics:

1. Audible alarm that activates as part of a safety device system.
2. Additional obstruction detector; noncontact **[infrared] [photoelectric] [radio-frequency barrier]**.
3. Gate-arm warning safety signs on both sides of unit to limit traffic to vehicular traffic.
4. Low-voltage **[yellow] [red]** warning lights that illuminate when gate is in down position.
5. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
6. LED integrated into gate-arm for increased visibility.
7. Manually operated crank for emergency operation.
8. Authorities having jurisdiction's emergency access by **<Insert type>**.
9. Gate-arm tip support **[with electromagnetic lock]**.
10. Gate-arm skirt bottom **[and top]**.

2.04 VEHICLE DETECTORS <Insert drawing designation>

- A. General: Provide detection devices that sense presence or transit of vehicles and emit signals activating gate-arm operators.
- B. Vehicle Loop Detector System: Self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light. Include automatic closing timer with adjustable time delay before closing **[, timer cut-off switch,]** designed to hold gate arm open until traffic clears. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location indicated on Drawings, as recommended in writing by detection system manufacturer for **[pave-over] [saw-cut]** installation.
 1. Field-Assembled Loop: Wire, in size indicated for field assembly.
 2. Factory-Formed Loop: Wire, preformed in size indicated.
 3. Operation:
 - a. Recognize vehicles within 6 inches of each other on standard-sized loop.
 - b. Recognize vehicle direction by detecting vehicle moving from one loop to another.
 - c. Generate reverse count if vehicle backs up after generating directional count in forward direction.
 - d. Continuous diagnostic monitoring **[and memory]**for intermittently operating and failed loops.
 - e. Crosstalk test between adjacent loops.

- C. Active Infrared Vehicle Detector: **[Retroreflective] [Emitter/receiver]**-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing **[, timer cut-off switch,]** and vehicle presence detector designed to hold gate arm open until traffic clears.

2.05 TRAFFIC CONTROLLERS <Insert drawing designation>

- A. General: Provide directional enforcement system that allows passage of vehicle in only one direction.
- B. Penetrating Type: System consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.
1. Mounting: **[Surface] [Recessed]**.
 2. Operation: **[Manual, with each tooth controlled by torsion spring] [Electromechanical] [Hydraulic]**.
 3. Latch Down: Allow disarming for two-way traffic flow. Furnish **[one] <Insert number>** tool(s) for latch-down operation.
 4. Illuminated Warning Signs: **[Single] [Double]**-faced warning signs consisting of LED lamps **[with photo cell control]** and keyed on/off override switches, contained in welded steel bodies with baked-enamel or powder-coat finish and fiberglass sign faces **[, with flood lamp]**.
 - a. Post Mounting: Provide **[in-ground] [surface-mounted]** base sleeves and posts.
 - b. Sign Copy: **["Wrong Way, Stop, Severe Tire Damage."] ["Warning, Do Not Back Up, Tire Damage."]** <Insert message.>
 5. Speed Bumps: **[Composite plastic] [Compression molded rubber compound]** for speed reduction to 5 mph or less.
- C. Nonpenetrating Type: System consisting of steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: **[Surface] [Recessed]**.
2. Operation: **[Manual] [Electromechanical] [Hydraulic]**.

2.06 ENTRY TERMINALS <Insert drawing designation>

- A. General: Provide entry terminals with mechanisms, components, and controllers housed in cabinet enclosures.
- B. Physical Characteristics:
1. Digital display, touchscreen, or LCD.

2. Time and date display.
3. Time Indicator: 24-hour cycle with **[A.M. and P.M.] [military-time]** clock mechanism.
4. Voice annunciation.
5. Tickets: **[Standard paper] [Magnetic stripe] [Barcode]**.
6. Removable ticket tray with capacity of **[5000] <Insert number>** fan-folded tickets.
7. Battery backup for clock and RAM memory.
8. Communication port.
9. Thermostatically controlled heater with on/off/auto switch.
10. Thermostatically controlled fan with on/off/auto switch.
11. Ticket printing and dispensing mechanism.
12. Credit card activation slot, credit card reader **[with smart card reader]**, and "Insert Ticket/Card" message.
13. Access card reader.
14. Multiple ticket option for valet parking.
15. Intercom.
16. Pinhole camera.
17. Barcode imager scanner.
18. Proximity access reader.
19. Automatic vehicle identification reader.
20. License plate recognition.

C. Operational Characteristics:

1. Operation: **[Standalone] [Online communication to remote computer]**.
2. Activation by **[button with "Push for Ticket" message] [vehicle detector] [credit card in/out] [license plate recognition] [automatic vehicle identification] [proximity] [scanned electronic or hardcopy media] [access card] <Insert device>**.
 - a. On activation by button, unit automatically records entry time **[, license plate,]** and date on ticket, **[sounds buzzer,]** dispenses ticket, and raises barrier gate.
 - b. On activation by means other than button, credentials are recorded and signal is automatically sent to raise barrier gate.
3. Credit card pay on entry.

4. Automatic ticket validation.
 5. Programmable ticket numbering.
 6. Programmable facility code.
 7. Programmable display.
 8. Programmable timer for closing barrier gate.
 9. Built-in-service diagnostics.
 10. Low-ticket alarm.
 11. Out-of-ticket alarm.
 12. Ticket jam detection.
 13. Test ticket printing.
 14. Back-out ticket function.
 15. Cancel transaction function.
- D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth, approximately 15 inches square by 40 inches tall; consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish **[two]** **<Insert number>** keys for each lock **[, all locks keyed alike]**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.
1. Steel Sheet: Not less than 0.097-inch-thick **[, galvanized-]** steel sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** **<Insert color>** baked-enamel or powder-coat finish.
 2. Aluminum Sheet: Not less than 0.125-inch-thick, aluminum sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** **<Insert color>** baked-enamel or powder-coat finish.
 3. Stainless-Steel Sheet: Not less than 0.109-inch-thick, stainless-steel sheet.
 - a. Finish cabinet exterior with No. 4 finish.
- E. Ticket-Dispensing Mechanisms: Removable assembly, with **[self-sharpening ticket cutter]** **[or]** **[ticket burster]** and plug-in controller.
- 2.07 EXIT TERMINALS **<Insert drawing designation>**
- A. General: Provide exit terminals with controllers and components housed in cabinet enclosures.
 - B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Communication port.
6. Thermostatically controlled heater with on/off/auto switch.
7. Thermostatically controlled fan with on/off/auto switch.
8. Credit card activation slot, credit card reader [**with smart card reader**], and "Insert Ticket/Card" message.
9. Access card reader.
10. Ticket reader.
11. Receipt printer.
12. Intercom.
13. Pinhole camera.
14. Barcode imager scanner.
15. Proximity access reader.
16. Automatic vehicle identification reader.
17. License plate recognition.

C. Operational Characteristics:

1. [Standalone] [Online communication to remote computer].
2. Activation by [ticket insertion] [vehicle detector] [credit card in/out] [license plate recognition] [automatic vehicle identification] [proximity] [scanned electronic or hardcopy media] [access card] <Insert device>.
3. Activation results in the following:
 - a. Valid Prepaid Exit: Signal is automatically sent to raise barrier gate.
 - b. Pay at Exit: Parking fee is calculated and displayed for payment.
 - c. Invalid Exit: Activation is rejected and "Pay Cashier First" or "Return to Cashier" message is displayed.
4. Programmable lost ticket function.
5. Display fee.

6. Accept payment by [credit card] [debit card] [smart card] [prepaid value card] [scanned media] [and] [merchant ticket].
 7. Accept discounted coupons.
 8. Print receipts on demand.
 9. Programmable facility code.
 10. Programmable grace period.
 11. Programmable display.
 12. Programmable timer for closing barrier gate.
 13. Reports for events and exception events.
 14. Programmable merchant validations.
 15. Built-in service diagnostics.
 16. Cancel transaction function.
- D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall. Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish **[two]** <Insert number> keys for each lock **[, all locks keyed alike]**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
1. Steel Sheet: Not less than 0.097-inch-thick **[, galvanized-]** steel sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** <Insert color> baked-enamel or powder-coat finish.
 2. Aluminum Sheet: Not less than 0.125-inch-thick, aluminum sheet.
 - a. Finish cabinet, interior and exterior, with manufacturer's standard **[white]** **[yellow]** <Insert color> baked-enamel or powder-coat finish.
 3. Stainless-Steel Sheet: Not less than 0.109-inch-thick, stainless-steel sheet.
 - a. Finish cabinet exterior with No. 4 finish.
- 2.08 PAY STATIONS <Insert drawing designation>
- A. General: Provide self-contained, cashiering **[central]** **[entry]** **[exit]** pay stations designed for self-service operation; with mechanisms, components, **[controllers,]** and fee computers housed in a combined enclosure.
 - B. Physical Characteristics:
 1. Digital display, touchscreen, or LCD.
 2. Time and date display.

3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Thermostatically controlled heater with on/off/auto switch.
6. Thermostatically controlled fan with on/off/auto switch.
7. Ticket printing and dispensing mechanism.
8. Credit card activation slot, credit card reader [**with smart card reader**], and "Insert Ticket/Card" message.
9. Bill acceptor.
10. Access card reader.
11. Ticket reader.
12. Printer.
13. Intercom.
14. Pinhole camera.
15. Barcode imager scanner.
16. Proximity access reader.
17. Automatic vehicle identification reader.
18. License plate recognition.

C. Operational Characteristics:

1. [Standalone] [Online communication to remote computer].
2. Activation by [ticket insertion] [vehicle detector] [credit card in/out] [license plate recognition] [automatic vehicle identification] [proximity] [scanned electronic or hardcopy media] [access card] <Insert device>.
3. Activation results in the following:
 - a. Valid Prepayment: Signal is automatically sent to raise barrier gate.
 - b. Payment Prompt: Parking fee is calculated and displayed for payment.
4. Compute multiple parking fees based on recorded entry times.
5. Compute multiple taxes by percentage and fixed amount.
6. Programmable lost ticket function.
7. Display fee.

8. Accept payment by cash and [credit card] [debit card] [scanned media] [smart card] [prepaid value card] [and] [merchant ticket].
 9. Accept discounted coupons.
 10. Compute change.
 11. Print receipts on demand.
 12. Print validation on ticket.
 13. Print audit trail.
 14. Programmable for up to [six] <Insert number> fee structures.
 15. Test mode to verify accuracy of fee structure program.
 16. Programmable time.
 17. Programmable facility code.
 18. Programmable grace period.
 19. Programmable display.
 20. Programmable timer for closing barrier gate.
 21. Programmable merchant validations.
 22. Built-in service diagnostics.
 23. Print cash audit, revenue, operational, and statistical reports on demand.
 24. Duress alarm output for emergencies.
 25. Cancel transaction function.
- D. Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately 36 inches wide by 18 inches deep by 60 inches tall. Provide single, gasketed access door with flush-mounted locks. Furnish [two] <Insert number> keys for each lock [, all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
1. Finish cabinet, interior and exterior, with manufacturer's standard [white] [yellow] <Insert color> baked-enamel or powder-coat finish.
- 2.09 FEE COMPUTERS <Insert drawing designation>
- A. General: Provide modular [PC-based] system. Register permanent record of each transaction in computer's memory.
 - B. Physical Characteristics:
 1. Touchscreen display.

2. Battery backup for clock and RAM memory.
3. Communication port.
4. [Cash drawer] [Two cash drawers].
5. Standard ticket reader.
6. Magnetic stripe ticket reader.
7. Barcode ticket reader.
8. Credit card reader [with smart card reader].
9. Access card reader.
10. Proximity access reader.
11. Automatic Vehicle Identification reader.
12. License plate recognition.
13. [Keyed] [Keyless-membrane] keypad.
14. Detachable printer.

C. Operational Characteristics:

1. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
2. Compute multiple taxes by percentage and fixed amount.
3. Programmable lost ticket function.
4. Display fee on remote fee display device.
5. Credit card in/out.
6. Accept payment by cash and [credit card] [debit card] [smart card] [prepaid value card] [and] [merchant ticket].
7. Accept discounted coupons.
8. Control independent cash drawer.
9. Compute change.
10. Print receipts.
11. Print validation on ticket.
12. Print audit trail.
13. Reload value cards.

14. Interface to automatic barrier gate.
 15. Programmable with up to **[six]** <Insert number> fee structures.
 16. Programmable time.
 17. Programmable keys.
 18. Programmable for special events validations.
 19. Programmable for automatic activation for limited date and time validations.
 20. Programmable merchant validations.
 21. Programmable valet parking.
 22. Programmable hotel guest parking.
 23. Three levels of security including cashier, supervisor, and master.
 24. Recall last transaction.
 25. Test mode to verify accuracy of fee structure program.
 26. Built-in service diagnostics.
 27. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
 28. Duress alarm output for emergencies.
- D. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.
- E. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of 1-inch-tall, digital displays or LCDs contained in welded steel bodies with baked-enamel or powder-coat finish.
1. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
 2. Mounting: **[Front of cashier's booth]** **[42-inch-high pedestal]**.
- 2.010 MISCELLANEOUS PARKING CONTROL EQUIPMENT
- A. "Lot Full" Signs <Insert drawing designation>: Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be **[4]** <Insert dimension> inches tall.
1. Type: **[Flashing]** **[Nonflashing]**.
 2. Operation: **[Manual by push button]** **[Automatic by barrier gate controller]**.
 3. Illumination: **[Traffic signal lamps and colored]** **[LED bulb and clear]** acrylic sign face.

4. Mounting: [Top of barrier gate cabinet] [42-inch-high pedestal].

2.011 PARKING FACILITY MANAGEMENT SOFTWARE

- A. General: Manufacturer's standard software that is compatible with security-access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.
- B. Operation:
 1. Collect data for revenue and activity reporting.
 2. Collect data for access and space control.
 3. Notification services.
 4. On-line prepaid parking.
 5. Event management.
 6. Validation solutions.
 7. License plate recognition systems.
 8. Pay-by-phone.
 9. Loyalty programs.
 10. Track tickets.
 11. Programmable parking control equipment.

2.012 ACCESS CONTROL UNITS <Insert drawing designation>

- A. General: Provide access control unit that activates barrier gates.
- B. Unit Housing: Fabricate from [welded cold-rolled steel or aluminum sheet] [plastic] with weatherproof front access panel equipped with flush-mounted lock and [two] <Insert number> keys. Provide face-lighted unit fully visible at night.
 1. Steel Finish: Manufacturer's standard baked-enamel or powder-coat finish system.
- C. Card Reader Controlled Unit: Functions only when authorized card is presented.
 1. System: [Magnetically coded, single-code system activated by coded card] [Programmable, multiple-code capability permitting validation or voiding of individual cards].
 - a. Permit four different access time periods.
 2. Reader Type: [Swipe] [Insertion] [Proximity].
 - a. Swipe reader for [magnetic-stripe] [barcode] [Wiegand] cards.

- b. Insertion reader for **[magnetic-stripe] [barcode] [Wiegand]** cards.
 - c. Proximity reader for proximity cards.
3. Operation: **[Standalone] [Online communication to remote parking control system computer] [Online communication to remote security-access control system computer]**.
 4. Characteristics: **[Timed antipassback] [Limited-time usage] [Capable of monitoring and auditing barrier gate activity] [Digital display or LCD] [Programmable by PDA (personal digital assistant) by infrared interface] <Insert feature>**.
 5. Mounting: **[With pedestal] [Wall] [In enclosed cabinet] [As indicated on Drawings] <Insert mounting>**.
 6. Cards: Provide **<Insert number>**.
 - a. Imprint cards with **<Insert special printing requirements such as company logo or emblem>**.
- D. Digital Keypad Controlled Unit: Functions only when authorized code is entered on **[keyed] [keyless-membrane]** keypad.
1. System: **[Multiple-code capability] [Programmable, multiple-code capability]**.
 - a. Multiple-code capability of no fewer than **[five] [100] [500] <Insert number>** possible individual codes.
 - b. Programmable, multiple-code capability permitting validation or voiding of no fewer than **[100] [2500] [10,000] <Insert number>** possible individual codes, consisting of **[one to six] <Insert number>** digits **[, and permitting four different access time periods]**.
 2. Operation: **[Standalone] [Online communication to remote parking control system computer] [Online communication to remote security-access control system computer]**.
 3. Characteristics: **[Timed antipassback] [Limited-time usage] [Capable of monitoring and auditing barrier gate activity] <Insert feature>**.
 4. Mounting: **[With pedestal] [Wall] [As indicated on Drawings] <Insert mounting>**.
- E. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver **[, one per barrier gate] [, where indicated on Drawings]**, remote antenna with coaxial cable and mounting brackets, and **[one permanently mounted] [four portable] <Insert number and use condition>** transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validation or voiding of no fewer than **[1000] [10,000] <Insert number>** codes per channel configured for the following functions:
1. Transmitters: **[Single-button] [Triple-button]** operated.
 - a. Single-button operated with **[open] [open and close]** functions.
 - b. Triple-button operated with open, close, and stop functions.

- 1) Provide transmitters featuring **[two] [three] [four] <Insert number>** independent channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

2.013 ANCHORAGES

- A. Anchor Bolts: **[Galvanized] [Stainless steel]**.
 1. Hot-dip galvanized according to ASTM A153/A153M and ASTM F2329/F2329M.
 2. Stainless steel, **[Type 304] [Type 316] [Type 304 or 316 as indicated] <Insert type>**.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including equipment bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before parking control equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

3.03 INSTALLATION, GENERAL

- A. Install parking control equipment as required for complete and integrated installation.
 1. Rough-in electrical connections.

3.04 INSTALLATION OF AUTOMATIC BARRIER GATES

- A. Anchor cabinets to concrete bases with anchor bolts or expansion anchors, and mount barrier gate arms.
 1. Install barrier gates according to UL 325.

3.05 INSTALLATION OF VEHICLE DETECTORS

- A. **[Cut grooves in pavement and bury] [Bury]** and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.

3.06 INSTALLATION OF TRAFFIC CONTROLLERS

- A. Anchor controllers to **[recessed concrete bases] [driveway surfaces]** with anchor bolts or expansion anchors.

3.07 INSTALLATION OF ENTRY TERMINALS

- A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.
 - 1. Connect equipment to remote computer.
 - 2. Load ticket dispenser with supply of tickets.

3.08 INSTALLATION OF EXIT TERMINALS

- A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.
 - 1. Connect equipment to remote computer.
 - 2. Load ticket dispenser with supply of tickets.

3.09 INSTALLATION OF PAY STATIONS

- A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.
 - 1. Connect equipment to remote computer.
 - 2. Load ticket dispenser with supply of tickets.

3.010 INSTALLATION OF FEE COMPUTERS

- A. Install computers at locations indicated, including connecting to peripheral equipment **[and remote computers]**.

3.011 INSTALLATION OF CARD READER PEDESTALS

- A. **[Pad] [In-ground]** mount with mounting bolts.

3.012 INSTALLATION OF ELECTRICAL

- A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.013 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- C. Perform the following tests and inspections [with the assistance of a factory-authorized service representative]:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Parking control equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.014 ADJUSTING

- A. Adjust parking control equipment to function smoothly, and lubricate as recommended by manufacturer.
- B. Confirm that locks engage accurately and securely without forcing or binding.
- C. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

3.015 PROTECTION

- A. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Substantial Completion.

3.016 MAINTENANCE SERVICE

- A. Maintenance Service Description: Beginning at Substantial Completion, maintenance service shall include **[three] [six] [nine] [12]** months' full maintenance by **[skilled employees of parking control equipment installer] [manufacturer's authorized service representative]**. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper parking control equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.017 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for **[two] <Insert number>** years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **[two] <Insert number>** years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least **[30] <Insert number>** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.018 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain parking control equipment.

3.019 PARKING CONTROL EQUIPMENT SCHEDULE

- A. Provide parking control equipment for each lane as follows:
 - 1. Lane <Insert designation>: <Insert list of equipment>.

END OF SECTION

SECTION 11 30 13
RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Kitchen exhaust ventilation.
3. Refrigeration appliances.
4. Cleaning appliances.
5. Trash compactors.

B. Related Requirements:

1. Section 22 41 00 "Residential Plumbing Fixtures" for kitchen sinks, dishwasher air-gap fittings, waste (garbage) disposers, and instant hot-water dispensers.

1.02 ALLOWANCES

- A. Furnish residential appliances as part of residential appliance allowance.
- B. Furnish <Insert item and drawing designation> as part of [residential appliance] <Insert allowance designation> allowance.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Cooking appliances.
2. Kitchen exhaust ventilation.
3. Refrigeration appliances.
4. Cleaning appliances.
5. Trash compactors.

B. Product Data Submittals: For each product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

- C. Samples: For each exposed product and for each color and texture specified, in **[manufacturer's standard]** <Insert dimensions> size.
- D. Product Schedule: For appliances.[Use same designations indicated on Drawings.]

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturers' special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintains, within <Insert miles> of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- B. Gas-Fuel Conversion: Provide gas-fueled appliances with manufacturer's **[high-altitude]** **[and]** **[propane]** conversion kit installed by a qualified service agency according to manufacturer's written instructions for Project location and type of fuel.

1.08 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period[.][**except as qualified below:**]
 - 1. Warranty Period: **[Two]** **[Five]** <Insert number> years from date of Substantial Completion.
- B. Electric Cooktop and Range: [Full warranty, including parts and labor,] [Limited warranty, including parts and labor for first year and parts thereafter,] <Insert description> for on-site service on surface-burner elements.
 - 1. Warranty Period: **[Two]** **[Five]** <Insert number> years from date of Substantial Completion.
- C. Microwave Oven: [Full warranty, including parts and labor,] [Limited warranty, including parts and labor for first year and parts thereafter,] for on-site service [on the magnetron tube] <Insert requirement>.
 - 1. Warranty Period: **[Two]** **[Five]** <Insert number> years from date of Substantial Completion.

- D. Refrigerator/Freezer, Freezer, and Icemaker, Sealed System: [Full warranty, including parts and labor,] [Limited warranty, including parts and labor for first year and parts thereafter,] for on-site service on the product.
1. Warranty Period for [**Sealed Refrigeration System**] <Insert item>: [**Two**] [**Five**] <Insert number> years from date of Substantial Completion.
 2. Warranty Period [**for Other Components**] <Insert requirement>: [**Two**] <Insert number> years from date of Substantial Completion.
- E. Dishwasher: [Full warranty, including parts and labor,] [Limited warranty, including parts and labor for first year and parts thereafter,] for on-site service on the product.
1. Warranty Period for [**Deterioration of Tub and Metal Door Liner**] <Insert requirement>: [**Three**] [**Five**] [**10**] <Insert number> years from date of Substantial Completion.
 2. Warranty Period [**for Other Components**] <Insert requirement>: [**Two**] <Insert number> years from date of Substantial Completion.
- F. Clothes Washer: [Full warranty, including parts and labor,] [Limited warranty, including parts and labor for first year and parts thereafter,] <Insert description> for on-site service on the product.
1. Warranty Period: [**Two**] [**Three**] <Insert number> years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. See current college Campus Specification Matrix for preferred manufacturers.

2.02 SOURCE LIMITATIONS

- A. Obtain [residential appliances from single source] [and] [each type of residential appliance from single manufacturer].
- B. All appliances must be consistent in finish.

2.03 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Gas-Fueled Appliances: Certified by a qualified testing agency for each type of gas-fueled appliance according to ANSI Z21 Series standards.
- C. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in [**the DOJ's 2010 ADA Standards for Accessible Design**] [**the ABA standards of the Federal agency having jurisdiction**] [and] [**ICC A117.1**] <Insert requirement>.

2.04 COOKING APPLIANCES

- A. Electric Cooktop <Insert drawing designation>:
1. Width: [**12 inches**] [**30 inches**] [**36 inches**] <Insert dimension>.
 2. Electric Burner Elements: [**Two**] [**Four**] [**Six**] <Insert number>.
 - a. Coil Type: [Manufacturer's standard] [Two 1200 W and two 2200 W] [One 1200 W, one 2200-W dual element, and two 2200 W] <Insert burner combination and power ratings>.
 - b. Radiant Type: [Two 1500 W and two 2000 W] [One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element] <Insert burner combination and power ratings>.
 - c. Induction Type: [Manufacturer's standard] [Two 1200 W and two 1800 W] [One 1200 W, one 1800 W, one 2700 W, and one 3300 W] <Insert burner combination and power ratings>.
 3. Controls: Digital panel controls, located [**on front**] [**on left side**] [**on right side**] [**remotely, where indicated**].
 4. Downdraft Ventilation: [**Manufacturer's standard**] [**550 cfm**] <Insert capacity> built-in downdraft ventilation, with [**remote**] blower and exterior weatherproof wall cap.
 5. Other Features: [**Grill**] [**deep fryer**] [**wok burner**] [**and**] [**wok ring**] <Insert feature>.
 6. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**] [**As indicated on Drawings**] <Insert requirement>.
 7. Top Material: [**Manufacturer's standard**] [**Ceramic glass**] [**Porcelain-enameled steel**] [**Stainless steel**] <Insert material>.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.
- B. Gas Cooktop <Insert drawing designation>:
1. Width: [**12 inches**] [**30 inches**] [**36 inches**] <Insert dimension>.
 2. Gas Burners: [**Two**] [**Four**] [**Six**] <Insert number>.
 - a. Power Ratings: [Manufacturer's standard] [One **5000 Btu/h**, two **9100 Btu/h**, and one **12,000 Btu/h**] <Insert burner combination and power ratings>.
 - b. Grates: [Individual] [Continuous] <Insert description>.
 3. Controls: [**Digital panel**] [**Manual-dial**] controls, located on [**front**] [**left side**] [**right side**].
 4. Downdraft Ventilation: [**Manufacturer's standard**] [**550 cfm**] <Insert capacity> built-in downdraft ventilation, with [**remote**] blower and exterior weatherproof wall cap.
 5. Other Features: [**Sealed burners**] [**auto-reigniting burners**] [**grill**] [**deep fryer**] [**wok burner**] [**and**] [**wok ring**] <Insert feature>.
 6. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 30 A**] [**As indicated on Drawings**] <Insert requirement>.
 7. Top Material: [**Manufacturer's standard**] [**Ceramic glass**] [**Porcelain-enameled steel**] [**Stainless steel**] <Insert material>.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.

- C. Electric Range <Insert drawing designation>: [**Freestanding**] [**Slide-in**] [**Drop-in**] range with [**one**] [**two**] oven(s) and complying with AHAM ER-1.
1. Width: [**30 inches**] [**36 inches**] <Insert dimension>.
 2. Electric Burner Elements: [**Four**] [**Six**] <Insert number>.
 - a. Coil Type: [Manufacturer's standard] [Two 1200 W and two 2200 W] [One 1200 W, one 2200-W dual element, and two 2200 W] <Insert burner combination and power ratings>.
 - b. Radiant Type: [Two 1500 W and two 2000 W] [One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element] <Insert burner combination and power ratings>.
 - c. Induction Type: [Manufacturer's standard] [Two 1200 W and two 1800 W] [One 1200 W, one 1800 W, one 2700 W, and one 3300 W] <Insert burner combination and power ratings>.
 - d. Controls: Digital panel controls, located on [**front**] [**left side**] [**right side**] [**splash panel at rear of rangetop**].
 - e. <Insert feature>.
 3. Oven Features:
 - a. Capacity: [**3.3 cu. ft.**] [and] <Insert capacity for each oven>.
 - b. Operation: [Baking] [convection] [and] [pyrolytic self-cleaning or catalytic continuous cleaning] <Insert requirement>.
 - c. Broiler: Located in [top of oven] [separate roll-out drawer on bottom].
 - d. Oven Door(s): Counterbalanced, removable, with [**observation window**] [and] [**full-width**] <Insert type of handle> handle.
 - e. Electric Power Rating:
 - 1) Oven(s): [Manufacturer's standard] [2400 W] [and] <Insert power rating for each oven>.
 - 2) Broiler: [Manufacturer's standard] [3500 W] <Insert power rating>.
 - f. Controls: Digital panel controls and timer display, located on [**front**] [**left side**] [**right side**] [**splash panel at rear of rangetop**].
 - g. <Insert feature>.
 4. Anti-Tip Device: Manufacturer's standard.
 5. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**] [**As indicated on Drawings**] <Insert requirement>.
 6. Material: [**Porcelain-enameled**] [**Stainless**] steel with [manufacturer's standard] [**ceramic-glass**] <Insert material> cooktop.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.

- D. Gas Range <Insert drawing designation>: [Freestanding] [Slide-in] range with [one] [two] oven(s).
1. Width: [**30 inches**] [**36 inches**] <Insert dimension>.
 2. Gas Burners: [**Four**] [**Six**] <Insert number>.
 - a. Power Ratings: [Manufacturer's standard] [One **5000 Btu/h**, two **9100 Btu/h**, and one **12,000 Btu/h**] <Insert burner combination and power ratings>.
 - b. Controls: [Digital panel] [Manual-dial] controls, located on [front] [left side] [right side] [splash panel at rear of rangetop].
 - c. Grates: [Individual] [Continuous] <Insert description>.
 - d. Other Feature(s): [Sealed burners] [auto-reigniting burners] [and] [grill] <Insert feature>.
 3. Oven Features:
 - a. Capacity: [**3.3 cu. ft.**] [and] <Insert capacity for each oven>.
 - b. Operation: [Baking] [convection] [and] [pyrolytic self-cleaning or catalytic continuous cleaning] <Insert requirement>.
 - c. Broiler: Located in [top of oven] [separate roll-out drawer on bottom].
 - d. Oven Door(s): Counterbalanced, removable, with [**observation window**] [and] [**full-width**] <Insert type of handle> handle.
 - e. Gas Power Ratings:
 - 1) Oven(s): [Manufacturer's standard] [**9100 Btu/h**] [and] <Insert power rating for each oven>.
 - 2) Broiler: [Manufacturer's standard] [**14,500 Btu/h**] <Insert power rating>.
 - f. Controls: [Digital panel] [Manual-dial] controls and timer display, located on [front] [left side] [right side] [splash panel at rear of rangetop].
 - g. <Insert feature>.
 4. Anti-Tip Device: Manufacturer's standard.
 5. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 15 A**] [**As indicated on Drawings**] <Insert requirement>.
 6. Material: [**Porcelain-enameled**] [**Stainless**] steel with [manufacturer's standard] [**ceramic-glass**] <Insert material> cooktop.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.
- E. Dual Fuel Range <Insert drawing designation>: [**Freestanding**] [**Slide-in**] range with gas burners and [**one**] [**two**] electric oven(s).
1. Width: [**30 inches**] [**36 inches**] <Insert dimension>.
 2. Gas Burners: [**Four**] [**Six**] <Insert number>.

- a. Power Ratings: [Manufacturer's standard] [One **5000 Btu/h**, two **9100 Btu/h**, and one **12,000 Btu/h**] <Insert burner combination and power ratings>.
 - b. Controls: [Digital panel] [Manual-dial] controls, located on [front] [left side] [right side] [splash panel at rear of rangetop].
 - c. Grates: [Individual] [Continuous] <Insert description>.
 - d. <Insert feature>.
3. Oven Features:
- a. Capacity: [**3.3 cu. ft.**] [and] <Insert capacity for each oven>.
 - b. Operation: [Baking] [convection] [and] [pyrolytic self-cleaning or catalytic continuous cleaning] <Insert requirement>.
 - c. Broiler: Located in [top of oven] [separate roll-out drawer on bottom].
 - d. Oven Door(s): Counterbalanced, removable, with [**observation window**] [and] [**full-width**] <Insert type of handle> handle.
 - e. Electric Power Rating:
 - 1) Oven(s): [Manufacturer's standard] [2400 W] [and] <Insert power rating for each oven>.
 - 2) Broiler: [Manufacturer's standard] [3500 W] <Insert power rating>.
 - f. Controls: [Digital panel] [Manual-dial] controls and timer display, located on [front] [left side] [right side] [splash panel at rear of rangetop].
 - g. <Insert feature>.
4. Anti-Tip Device: Manufacturer's standard.
5. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**] [As indicated on Drawings] <Insert requirement>.
6. Material: [**Porcelain-enameled**] [**Stainless**] steel with [manufacturer's standard] [**ceramic-glass**] <Insert material> cooktop.
- a. Color/Finish: [White] [Black] <Insert color or finish>.
- F. Electric Wall Oven <Insert drawing designation>: [**One**] [**Two**]-oven unit.
1. Mounting: Built-in [**wall**] [**undercounter**] <Insert requirement>.
 2. Capacity: [**3.3 cu. ft.**] [and] <Insert capacity for each oven>.
 3. Operation: [**Baking**] [convection] [and] [**pyrolytic self-cleaning or catalytic continuous cleaning**] <Insert requirement>.
 4. Broiler: Located in [**top of oven**] [**separate roll-out drawer on bottom**] <Insert requirement>.

5. Oven Door(s): Counterbalanced, removable, with **[observation window] [and] [full-width] <Insert type of handle>** handle.
 6. Electric Power Rating:
 - a. Oven(s): [Manufacturer's standard] [2400 W] [and] <Insert power rating for each oven>.
 - b. Broiler: [Manufacturer's standard] [3500 W] <Insert power rating>.
 7. Electric Power Supply: **[240 V, 60 Hz, 1 phase, 30 A] [As indicated on Drawings] <Insert requirement>**.
 8. Controls: **[Digital panel] [Manual-dial]** controls and timer display.
 9. **<Insert feature>**.
 10. Material: **[Porcelain-enameled steel] [Stainless steel] [Manufacturer's standard] <Insert material>**.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.
- G. Gas Wall Oven **<Insert drawing designation>**: **[One] [Two]**-oven unit.
 1. Mounting: Built-in **[wall] [undercounter] <Insert requirement>**.
 2. Capacity: **[3.3 cu. ft.] [and] <Insert capacity for each oven>**.
 3. Operation: **[Baking] [convection] [and] [pyrolytic self-cleaning or catalytic continuous cleaning] <Insert requirement>**.
 4. Broiler: Located in **[top of oven] [separate roll-out drawer on bottom] <Insert requirement>**.
 5. Oven Door(s): Counterbalanced, removable, with **[observation window] [and] [full-width] <Insert type of handle>** handle.
 6. Gas Power Ratings:
 - a. Oven(s): [Manufacturer's standard] **[9100 Btu/h]** [and] <Insert power rating for each oven>.
 - b. Broiler: [Manufacturer's standard] **[14,500 Btu/h]** <Insert power rating>.
 7. Electric Power Supply: **[120 V, 60 Hz, 1 phase, 30 A] [As indicated on Drawings] <Insert requirement>**.
 8. Controls: **[Digital panel] [Manual-dial]** controls and timer display
 9. **<Insert feature>**.
 10. Material: **[Porcelain-enameled steel] [Stainless steel] [Manufacturer's standard] <Insert material>**.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.

H. Microwave Oven **<Insert drawing designation>**:

 1. Mounting: **[Undercabinet] [Wall cabinet] <Insert requirement>**.
 2. Type: **[Conventional] [Convection] <Insert type>**.
 3. Dimensions:

- a. Width: **[24 inches]** **[30 inches]** [As indicated on Drawings] <Insert dimension>.
 - b. Depth: **[19-1/2 inches]** [As indicated on Drawings] <Insert dimension>.
 - c. Height: **[14 inches]** **[18 inches]** [As indicated on Drawings] <Insert dimension>.
4. Capacity: **[1.5 cu. ft.]** **[2.0 cu. ft.]** <Insert capacity>.
 5. Oven Door: Door with observation window **[and pull handle]** **[and pushbutton latch release]** <Insert requirement>.
 6. Exhaust Fan: **[Variable]** **[Two]** **[Four]**-speed fan, **[vented to outside]** **[nonvented, recirculating type with charcoal filter]** and with **[manufacturer's standard]** **[300 cfm]** <Insert value> capacity.
 7. Microwave Power Rating: **[Manufacturer's standard]** **[1000 W]** <Insert power rating>.
 - a. Convection Element Power Rating: [Manufacturer's standard] [1450 W] <Insert power rating>.
 8. Electric Power Supply: **[120 V, 60 Hz, 1 phase, 15 A]** **[As indicated on Drawings]** <Insert requirement>.
 9. Controls: Digital panel controls and timer display.
 10. Other Features: **[Turntable]** **[temperature probe]** **[and]** **[lock-out feature]** <Insert feature>.
 11. Material: **[Porcelain-enameled steel]** **[Stainless steel]** **[Manufacturer's standard]** <Insert material>.
 - a. Color/Finish: [White] [Black] <Insert color or finish>.

2.05 KITCHEN EXHAUST VENTILATION

- A. Overhead Exhaust Hood <Insert drawing designation>:
 1. Type: **[Wall-mounted,]** **[Suspended-island-canopy,]** <Insert requirement> exhaust-hood system.
 2. Dimensions:
 - a. Width: **[30 inches]** **[36 inches]** **[48 inches]** [As indicated on Drawings] <Insert dimension>.
 - b. Depth: **[30 inches]** **[36 inches]** **[48 inches]** [As indicated on Drawings] <Insert dimension>.
 3. Exhaust Fan: **[Variable]** **[Two]** **[Three]**-speed fan **[built into hood]** **[remotely located, with separate housing]** and with **[manufacturer's standard]** **[500 cfm]** **[900 cfm]** <Insert value> capacity.
 - a. Venting: [Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening] [Vented to outside through wall with weatherproof wall cap, backdraft damper, and rodent-proof screening] [Nonvented, recirculating type with charcoal filter] [As indicated on Drawings] <Insert requirement>.

- b. Fan Control: [**Hood**] [**Wall**]-mounted[**touch-pad to control**] fan switch, with separate hood-light control switch.
- 4. Duct Type: [**Manufacturer's standard**] [**7-inch-diameter round**] [**3-1/4 by 10 inches rectangular**] [**As indicated on Drawings**] <Insert requirement>.
- 5. Finish: [**Baked enamel**] [**Stainless steel**] <Insert finish>.
 - a. Color: [White] <Insert color>.
- 6. Features:
 - a. Permanent, washable [aluminum-mesh] [stainless steel-mesh] [baffle-type] filter(s).
 - b. Built-in [halogen] [incandescent] [fluorescent] lighting.
 - c. Warming lamp socket(s).
 - d. <Insert feature>.

B. Downdraft Exhaust <Insert drawing designation>:

- 1. Type: [**Retractable-downdraft**] <Insert requirement> exhaust system.
- 2. Width: [**30 inches**] [**36 inches**] [**As indicated on Drawings**] <Insert dimension>.
- 3. Exhaust Fan: [**Variable**] [**Two**] [**Three**]-speed fan [**built into cabinet below countertop**] [**remotely located, with separate housing**] and with [**manufacturer's standard**] [**500 cfm**] [**900 cfm**] <Insert value> capacity.
 - a. Venting: [Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening] [Vented to outside through wall with weatherproof wall cap, backdraft damper, and rodent-proof screening] [Nonvented, recirculating type with charcoal filter] [**As indicated on Drawings**] <Insert requirement>.
 - b. Fan Control: [Countertop] <Insert location>-mounted[touch-pad to control] fan switch.
- 4. Duct Type: [**Manufacturer's standard**] [**7-inch-diameter round**] [**3-1/4 by 10 inches rectangular**] <Insert requirement>.
- 5. Finish: [**Baked enamel**] [**Stainless steel**] <Insert finish>.
 - a. Color: [White] <Insert color>.
- 6. Features:
 - a. Permanent, washable [aluminum-mesh] [stainless steel-mesh] [baffle-type] filter(s).
 - b. <Insert feature>.

2.06 REFRIGERATION APPLIANCES

- A. Refrigerator/Freezer <Insert drawing designation>: [One-door refrigerator with freezer compartment inside] [Two-door, side-by-side refrigerator/freezer] [Two-door refrigerator/freezer with freezer on top] [Two-door refrigerator/freezer with freezer on bottom] <Insert description> and complying with AHAM HRF-1.

1. Type: [**Freestanding**] [**Built in**] [**Undercounter**].
2. Dimensions:
 - a. Width: [**16 inches**] [**24 inches**] [**27 inches**] [**30 inches**] [**36 inches**] [**42 inches**] [**48 inches**] [As indicated on Drawings] <Insert dimension>.
 - b. Depth: [**24 inches**] [**27 inches**] [**33-1/4 inches**] [As indicated on Drawings] <Insert dimension>.
 - c. Height: [**34-1/2 inches**] [**70 inches**] [**73 inches**] [**84 inches**] [As indicated on Drawings] <Insert dimension>.
3. Storage Capacity:
 - a. Refrigeration Compartment Volume: [**15.6 cu. ft.**] <Insert volume>.
 - b. Freezer Volume: [**5.13 cu. ft.**] <Insert volume>.
 - c. Shelf Area: [**Three**] <Insert number> adjustable [**wire**] [**glass**] shelves, [**26 sq. ft.**] <Insert area>.
 - d. <Insert storage requirement>.
4. General Features:
 - a. Door Configuration: [**Framed**] [**Overlay**].
 - b. Dispenser in door for [ice] [and] [cold water] [with dispenser lock].
 - c. Built-in water-filtration system.
 - d. Dual refrigeration systems.
 - e. Separate[**touch-pad**] temperature controls for each compartment.
 - f. <Insert feature>.
5. Refrigerator Features:
 - a. Interior light in refrigeration compartment.
 - b. Compartment Storage: [Wine racks] [vegetable crisper] [and] [meat compartment] <Insert requirement>.
 - c. Door Storage: [Glazed door without storage] [Modular compartments] [**1 gal.** milk-container storage] <Insert requirement>.
 - d. Temperature-controlled meat/deli bin.
 - e. <Insert feature>.
6. Freezer Features: [**One**] [**Two**] <Insert number> freezer compartment(s) [**with door(s)**] [**configured as pull-out drawer(s)**].

- a. [Automatic] [Manual] defrost.
 - b. Interior light in freezer compartment.
 - c. Automatic icemaker and storage bin.
 - d. <Insert feature>.
7. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
8. Front Panel(s): **[Manufacturer's standard] [Wood panel(s) to match kitchen cabinets] [Porcelain enamel] [Stainless steel] [Wood-panel insert(s) specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets] [Wood-panel insert(s) specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets] [Reversible panel(s) with choice of colors] <Insert description>.**
- a. Panel Color: [White] [Black] <Insert color(s)>.
9. Appliance Color/Finish: **[White] [Black] [Stainless steel] <Insert color or finish>.**
- B. Freezer <Insert drawing designation>: [One] [Two] <Insert number> freezer compartment(s) [with door(s)] [configured as pull-out drawer(s)] <Insert description> and complying with AHAM HRF-1.
1. Type: **[Freestanding] [Built in] [Undercounter].**
 2. Dimensions:
 - a. Width: **[27 inches] [30 inches] [36 inches]** [As indicated on Drawings] <Insert dimension>.
 - b. Depth: **[24 inches] [27 inches]** [As indicated on Drawings] <Insert dimension>.
 - c. Height: **[34-1/2 inches] [70 inches] [73 inches] [84 inches]** [As indicated on Drawings] <Insert dimension>.
 3. Storage Capacity:
 - a. Volume: **[5.13 cu. ft.] [15.0 cu. ft.]** <Insert volume>.
 - b. Shelf Area: **[Three]** <Insert number> adjustable **[wire] [glass]** shelves, **[26 sq. ft.] <Insert area>.**
 4. Features:
 - a. Door Configuration: **[Framed] [Overlay].**
 - b. [Automatic] [Manual] defrost.
 - c. Interior light in compartment.
 - d. Automatic icemaker and storage bin.
 - e. Temperature **[touch-pad]** controls for **[each]** compartment.

- f. Defrost drain.
 - g. Lock with key.
 - h. <Insert feature>.
5. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
6. Front Panel(s): **[Manufacturer's standard] [Wood panel(s) to match kitchen cabinets] [Porcelain enamel] [Stainless steel] [Wood-panel insert(s) specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets] [Wood-panel insert(s) specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets]** <Insert description>.
- a. Panel Color: [White] [Black] <Insert color(s)>.
7. Appliance Color/Finish: **[White] [Black] [Stainless steel]** <Insert color or finish>.
- C. Icemaker <Insert drawing designation>:
- 1. Type: **[Undercounter]** <Insert requirement>.
 - 2. Dimensions:
 - a. Width: **[14-3/4 inches] [15-1/4 inches]** [As indicated on Drawings] <Insert dimension>.
 - b. Depth: **[24 inches] [25-1/4 inches]** [As indicated on Drawings] <Insert dimension>.
 - c. Height: **[33-5/8 inches] [34-1/2 inches]** [As indicated on Drawings] <Insert dimension>.
 - 3. Ice Capacity:
 - a. Production: **[30 lb] [50 lb]** <Insert value> per day.
 - b. Storage: **[25 lb] [35 lb]** <Insert value>.
 - 4. Features:
 - a. Door Configuration: **[Framed] [Overlay]**.
 - b. [Automatic defrost] <Insert requirement>.
 - c. Automatic shutoff.
 - d. Defrost drain[**with pump**].
 - e. <Insert feature>.
 - 5. Front Panel: **[Manufacturer's standard] [Wood panel to match kitchen cabinets] [Porcelain enamel] [Stainless steel] [Wood-panel insert specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets] [Wood-panel insert specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets]** <Insert description>.

- a. Panel Color: [White] [Black] <Insert color(s)>.
6. Appliance Color/Finish: [**White**] [**Black**] [**Stainless steel**] <Insert color or finish>.

2.07 CLEANING APPLIANCES

- A. Dishwasher <Insert drawing designation>: Complying with AHAM DW-1.
 1. Type: [**Built-in undercounter**] [**Built-in under sink**] [**Portable**] <Insert type>.
 2. Dimensions:
 - a. Width: [**18 inches**] [**24 inches**] [As indicated on Drawings] <Insert dimension>.
 - b. Depth: [**23 inches**] [**25-3/4 inches**] [As indicated on Drawings] <Insert dimension>.
 - c. Height: [**34-1/2 inches**] [As indicated on Drawings] <Insert dimension>.
 3. Capacity:
 - a. International Place Settings of China: [**Eight**] [**12**] [**14**] <Insert number>.
 - b. Water Consumption for Full Load: [**3.2 gal.**] <Insert value> per cycle.
 4. Sound Level: Maximum [**42**] [**48**] <Insert number> dB.
 5. Tub and Door Liner: [**Manufacturer's standard**] [**Porcelain-enameled steel**] [**Stainless steel**] [**Porcelain-enameled steel tub and molded-plastic door liner**] <Insert requirement> with sealed detergent and automatic rinsing-aid dispensers.
 6. Rack System: [**Nylon**] [**PVC**]-coated sliding dish racks, with [**removable cutlery basket**] [**top cutlery tray**] <Insert feature>.
 7. Controls: [**Touch-pad**] [**Rotary-dial**] <Insert description> controls with [**four**] <Insert number> wash cycles and hot-air and heat-off drying cycle options.
 8. Features:
 - a. Waste food disposer.
 - b. Self-cleaning food-filter system.
 - c. Hot-water booster heater for [**140 deg F**] [**160 deg F**] wash water with incoming water at 100 deg F.
 - d. Lock-out feature.
 - e. Half-load option.
 - f. Delay-wash option.
 - g. Digital display panel.
 - h. Water softener.
 - i. Soil-sensing water use control system.

- j. <Insert feature>.
 - 9. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
 - 10. Front Panel: [**Manufacturer's standard**] [**Wood panel to match kitchen cabinets**] [**Porcelain enamel**] [**Stainless steel**] [**Wood-panel insert specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets**] [**Wood-panel insert specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets**] [**Reversible panel with choice of colors**] <Insert description>.
 - a. Panel Color: [White] [Black] <Insert color(s)>.
 - 11. Appliance Color/Finish: [**White**] [**Black**] [**Stainless steel**] <Insert color or finish>.
- B. Clothes Washer <Insert drawing designation>: Complying with AHAM HLW-1.
- 1. Type: [**Freestanding**] [**Stacking**] [**Undercounter**], [**top**] [**front**]-loading unit.
 - 2. Dimensions:
 - a. Width: [**23-1/2 inches**] [**27 inches**] [**30 inches**] [As indicated on Drawings] <Insert dimension>.
 - b. Depth: [**24 inches**] [**29 inches**] [**31 inches**] [As indicated on Drawings] <Insert dimension>.
 - c. Height: [**34-1/2 inches**] [**38 inches**] [**45 inches**] [As indicated on Drawings] <Insert dimension>.
 - 3. Drum: [**Manufacturer's standard**] [**Perforated porcelain-enameled steel**] [**Perforated stainless steel**] <Insert material>.
 - a. Capacity: [**2.7 cu. ft.**] [**3.2 cu. ft.**] [**3.8 cu. ft.**] <Insert volume>.
 - 4. Controls: [**Touch-pad**] [**Rotary-dial**] controls for water-fill levels, wash/rinse water temperatures, <Insert function,> and variable-speed and fabric selectors.
 - a. Wash Cycles: [**Four**] [**Six**] [**10**] <Insert number> wash cycles, including regular, delicate, and permanent press.
 - b. Wash Temperatures: [**Three**] <Insert number> settings.
 - c. Speed Combinations: [**Two**] [**Four**] [**Five**].
 - 5. Electrical Power: [**120 V, 60 Hz, 1 phase, 15 A**] [As indicated on Drawings] <Insert requirement>.
 - 6. Motor: Manufacturer's standard with built-in overload protector.
 - 7. Features:
 - a. Agitator: [Center spindle] [Impeller (without spindle)].
 - b. Self-cleaning lint filter.
 - c. Unbalanced-load compensator.

- d. Inlet Hoses: Minimum length 60 inches.
 - e. Drain Hoses: Minimum length 48 inches.
 - f. Self-leveling legs.
 - g. Automatic dispenser for [**bleach**] [**fabric softener**] [**and**] [**detergent**].
 - h. Spin-cycle safety switch.
 - i. End-of-cycle signal.
 - j. Extra-rinse option.
 - k. Delay-wash option.
 - l. Electronic temperature control.
 - m. Water levels automatically set.
 - n. Pedestal: [**8-inch-high**] [**15-inch-high**] [**Manufacturer's standard height**] <Insert **dimension**> laundry pedestal with storage drawer, matching appliance finish.
 - o. <Insert feature>.
8. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
9. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
10. Appliance Finish: [**Enamel**] [**Stainless steel**] <Insert **finish**>.
- a. Color: [White] [Almond] <Insert color>.
11. Front-Panel Finish: [**Manufacturer's standard**] [**Wood panel to match kitchen cabinets**] [**Porcelain enamel**] [**Stainless steel**] [**Wood-panel insert specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets**] [**Wood-panel insert specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets**] <Insert **description**>.
- a. Panel Color: [White] [Black] <Insert color(s)>.
- C. Clothes Dryer <Insert **drawing designation**>: Complying with AHAM HLD-1.
- 1. Type: [**Freestanding**] [**Stacking**] [**Undercounter**], frontloading, [**gas**] [**electric**] [**electric, ventless**] unit.
 - 2. Dimensions:
 - a. Width: [**23-1/2 inches**] [**27 inches**] [As indicated on Drawings] <Insert dimension>.
 - b. Depth: [**24 inches**] [**31 inches**] [As indicated on Drawings] <Insert dimension>.
 - c. Height: [**34-1/2 inches**] [**36 inches**] [As indicated on Drawings] <Insert dimension>.

3. Drum: **[Manufacturer's standard] [Perforated porcelain-enameled steel] [Perforated stainless steel]** <Insert material>.
 - a. Capacity: **[5.7 cu. ft.] [7.0 cu. ft.]** <Insert volume>.
 4. Controls: **[Touch-pad] [Rotary-dial]** controls for drying cycle, temperatures, <Insert function,> and fabric selectors.
 5. Electric-Dryer Power: **[240 V, 60 Hz, 1 phase, 30 A] [As indicated on Drawings]** <Insert requirement>.
 6. Gas-Dryer Power: **[120 V, 60 Hz, 1 phase, 15 A electric; 22,000-Btu/h gas]** [As indicated on Drawings] <Insert requirement>.
 7. Features:
 - a. Removable lint filter.
 - b. Electronic temperature and moisture-level-sensor controls.
 - c. End-of-cycle signal.
 - d. Interior drum light.
 - e. Self-leveling legs.
 - f. Antibacterial cycle.
 - g. Auxiliary drying rack.
 - h. Built-in electrical power fuse.
 - i. Stacking kit to stack dryer over washer.
 - j. Pedestal: **[8-inch-high] [15-inch-high] [Manufacturer's standard height]** <Insert dimension> laundry pedestal with storage drawer, matching appliance finish.
 - k. <Insert feature>.
 8. Appliance Finish: **[Enamel] [Stainless steel]** <Insert finish>.
 - a. Color: [White] [Almond] <Insert color>.
 9. Front-Panel Finish: **[Manufacturer's standard] [Wood panel to match kitchen cabinets] [Porcelain enamel] [Stainless steel] [Wood-panel insert specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets] [Wood-panel insert specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets]** <Insert description>.
 - a. Panel Color: [White] [Black] <Insert color(s)>.
- D. Clothes Washer/Dryer Combination <Insert drawing designation>: Complying with AHAM HLW-1.
1. Type: Freestanding washer/dryer unit with **[dual-drum design and electric dryer] [dual-drum design and gas dryer] [all-in-one, single-drum design]**; washer is **[top] [front]** loading.

2. Dimensions:
 - a. Width: **[23-1/2 inches]** **[27 inches]** [As indicated on Drawings] <Insert dimension>.
 - b. Depth: **[25 inches]** **[32 inches]** [As indicated on Drawings] <Insert dimension>.
 - c. Height: **[34-1/2 inches]** **[71-1/2 inches]** [As indicated on Drawings] <Insert dimension>.
3. Washer and Dryer Drums: **[Manufacturer's standard]** **[Perforated porcelain-enameled steel]** **[Perforated stainless steel]** <Insert material>.
 - a. Washer-Drum Capacity: **[1.5 cu. ft.]** **[2.0 cu. ft.]** **[2.6 cu. ft.]** <Insert volume>.
 - b. Dryer-Drum Capacity: **[2.0 cu. ft.]** **[3.4 cu. ft.]** **[5.9 cu. ft.]** <Insert volume>.
4. Washer/Dryer Drum: **[Manufacturer's standard]** **[Perforated stainless steel]** <Insert material>.
 - a. Drum Capacity: **[2.3 cu. ft.]** **[3.6 cu. ft.]** <Insert volume>.
5. Washer Controls: **[Touch-pad]** **[Rotary-dial]** controls for water-fill levels, wash/rinse water temperatures, <Insert function,> and variable-speed and fabric selectors.
6. Dryer Controls: **[Touch-pad]** **[Rotary-dial]** controls for drying cycle, temperatures, <Insert function,> and fabric selectors.
 - a. Wash Cycles: **[Three]** <Insert number> wash cycles, including regular, delicate, and permanent press.
 - b. Wash Temperatures: **[Three]** <Insert number> settings.
 - c. Speed Combinations: **[Two]** <Insert number>.
7. Electric Washer/Dryer Power: **[240 V, 60 Hz, 1 phase, 30 A]** **[120 V, 60 Hz, 1 phase, 12 A]** **[As indicated on Drawings]** <Insert requirement>.
8. Gas Washer/Dryer Power: **[120 V, 60 Hz, 1 phase, 15 A electric; 22,000 Btu/h gas]** **[As indicated on Drawings]** <Insert requirement>.
9. Motor: Manufacturer's standard with built-in overload protector.
10. Washing Features:
 - a. Self-cleaning lint filter.
 - b. Unbalanced-load compensator.
 - c. Inlet Hoses: Minimum length 60 inches.
 - d. Drain Hoses: Minimum length 48 inches.
 - e. Self-leveling legs.
 - f. Automatic dispenser for **[bleach]** **[fabric softener]** **[and]** **[detergent]**.

- g. Spin-cycle safety switch.
 - h. <Insert feature>.
11. Drying Features:
- a. Removable lint filter.
 - b. Electronic temperature and moisture-level-sensor controls.
 - c. End-of-cycle signal.
 - d. Interior drum light.
 - e. <Insert feature>.
12. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
13. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
14. Appliance Finish: [**Enamel**] [**Stainless steel**] <Insert finish>.
- a. Color: [White] [Almond] <Insert color>.

2.08 TRASH COMPACTORS

- A. Trash Compactor <Insert drawing designation>: Complying with AHAM TC-1.
- 1. Type: [**Built in**] [**Convertible**].
 - 2. Width: [**15 inches**] [**18 inches**].
 - 3. Capacity: [**1.4 cu. ft.**] [**1.7 cu. ft.**] <Insert volume>.
 - 4. Features:
 - a. Key-operated starting switch.
 - b. Rear wheels.
 - c. Removable bag carrier.
 - d. Retainer for disposable bags.
 - e. Odor-control mechanism.
 - f. Foot-operated drawer operator.
 - g. <Insert feature>.
 - 5. Front Panel: [**Manufacturer's standard**] [**Wood panel to match kitchen cabinets**] [**Enameled steel**] [**Stainless steel**] [**Wood-panel insert specified in Section 06 41 13 "Wood-Veneer-Faced Architectural Cabinets" to match kitchen cabinets**] [**Wood-panel insert specified in Section 12 35 30 "Residential Casework" to match kitchen cabinets**] <Insert description>.

- a. Panel Color: [White] [Black] <Insert color(s)>.

2.09 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Examine walls, ceilings, and roofs for suitable conditions where [**overhead exhaust hoods**] [**downdraft exhaust**] [**and**] [**microwave ovens with vented exhaust fans**] will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install appliances according to manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION

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SECTION 11 52 13
PROJECTION SCREENS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Manually operated, front-projection screens.
2. Electrically operated, front-projection screens.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for metal support framing for front-projection screens.
2. Section 06 10 00 "Rough Carpentry" for wood backing for screen installation.
3. Section 06 40 23 "Interior Architectural Woodwork" for **[wood trim] [wood trim and wood ceiling closure panel]** for recessed screen installation.
4. Section 11 52 13.19 "Rear Projection Screens."

1.02 DEFINITIONS

- A. ALR: Ambient-light rejection; for specular reflective viewing surfaces, measured as the percentage of ambient light striking the viewing surface that has equal angles of incidence and reflection.
- B. Gain: Ratio of light reflected from viewing-surface material to that reflected perpendicularly from a magnesium carbonate surface as determined in accordance with SMPTE RP 94.
- C. Half-Gain Angle: The angle, measured from the axis of the viewing surface to the most central position on a perpendicular plane through the horizontal centerline of the viewing surface, where the gain is half of the peak gain.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show layouts and types of front-projection screens. Include the following:
 1. Drop heights.
 2. Location of seams in viewing surfaces.
 3. For end-mounted motors, location of screen centerline relative to ends of screen case.
 4. Anchorage details, including connection to supporting structure for suspended units.
 5. Details of juncture of screen case or trim with adjacent finishes.
 6. For electrically operated units, wiring diagrams and location of wiring connections.
 7. Accessories.

- C. Samples: For each type of exposed finish and for each color and finish specified, in manufacturer's standard sizes.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.
- F. Product Schedule: For front-projection screens. [Use same designations indicated on Drawings.]

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For front-projection screens to include in maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver front-projection screens until spaces are enclosed and weathertight, wet-work in installation spaces is complete and dry, and temporary or permanent HVAC system is operating and maintaining ambient temperature and humidity conditions planned for building occupants during the remainder of the construction period.
- B. Store front-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.06 COORDINATION

- A. Coordinate layout and installation of front-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC system components, **[fire-suppression system,]** and partitions.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Source Limitations for Projection Screens: Obtain **[front-projection screens]** **[each type of front-projection screen]** from single manufacturer. Obtain viewing surfaces and accessories, including mounting hardware, from screen manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Viewing-Surface and Masking Materials:
 1. Mildew-Resistance Rating: Zero or 1 when tested in accordance with ASTM G21.
 2. Flame Resistance: Passes NFPA 701.
 3. Flame-Spread Index: Not greater than 75 when tested in accordance with ASTM E84.

2.03 MANUALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General Requirements: Manufacturer's standard spring-roller-operated units, consisting of case, flexible screen, mounting accessories, and other components necessary for a complete installation.

1. Screen Mounting: Top edge securely anchored to a rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
- B. Metal-Encased, Manually Operated Screen <Insert drawing designation>: Unit with free-hanging screen; with screen case fabricated from formed-steel sheet or aluminum extrusions with manufacturer's standard finish and matching end caps.
1. Surface-Mounting Configuration: [Mounted using manufacturer's standard projecting wall brackets] [Mounted directly to wall or ceiling, as indicated on Drawings, with concealed mounting] [Recessed in ceiling trough indicated on Drawings, with concealed mounting] <Insert requirements>.
 2. Screen Case Color: [As selected by Architect from manufacturer's standard options] [White] [Black] <Insert requirements>.
 3. Matte Viewing Surface: [White, 1.0 minimum peak gain and 60-degree minimum half-gain angle] [White, 1.0 minimum peak gain and material does not reach half gain] [Gray, 0.8 minimum peak gain and material does not reach half gain] <Insert requirements>.
 4. Viewing Surface: <Insert requirements>.
 5. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [top] [bottom] [location indicated on Drawings] <Insert requirements> of viewing surface.
 6. Edge Treatment: [Black] [Without black] masking borders.
 7. Size of Viewing Surface: [As indicated in schedule on Drawings] [40 by 64 inches] [50 by 80 inches] [40-1/2 by 72 inches] [57-1/2 by 92 inches] [45 by 80 inches] [52 by 92 inches] <Insert dimensions>.
 8. Extra Drop Height: [As indicated in schedule on Drawings] [As needed at top of screen for bottom of screen to be 36 inches above floor] [36 inches at bottom of screen] <Insert requirements>.
 - a. Color: [Same as viewing surface] [Black].
- C. Wood-Finished, Manually Operated Screen <Insert drawing designation>: Unit with free-hanging screen; with screen case with flat back, hardwood finish, and concealed mounting brackets for surface mounting on wall or ceiling, as indicated on Drawings.
1. Screen Case Hardwood: [Oak] [Walnut] [Mahogany] [Cherry] [As selected by Architect from manufacturer's full range of species] <Insert species>.
 - a. Corners: [Radiused] [Rectilinear] [Traditional crown trim at top, rectilinear at sides and bottom] [Beveled at top, eased at sides and bottom] <Insert requirements>.
 - b. Finish: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert requirements>.
 2. Matte Viewing Surface: [White, 1.0] [Gray, 0.8] <Insert requirements> minimum peak gain; material does not reach half-gain.
 3. Viewing Surface: <Insert requirements>.
 4. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [top] [bottom] [location indicated on Drawings] <Insert requirements> of viewing surface.
 5. Edge Treatment: [Black] [Without black] masking borders.

6. Size of Viewing Surface: [As indicated in schedule on Drawings] **[50 by 80 inches]** **[57-1/2 by 92 inches]** **[45 by 80 inches]** **[52 by 92 inches]** <Insert dimensions>.
7. Extra Drop Height: [As indicated in schedule on Drawings] [As needed at top of screen for bottom of screen to be **36 inches** above floor] **[36 inches]** at bottom of screen <Insert requirements>.
 - a. Color: [Same as viewing surface] **[Black]**.

2.04 ELECTRICALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General Requirements: Manufacturer's standard units, consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. **[Provide units that are listed and labeled as an assembly by Underwriters Laboratories Inc. (UL) or another testing and inspecting agency acceptable to authorities having jurisdiction.]**
 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a metal rod, with ends of rod protected by plastic caps.
- B. Surface-Mounted, Metal-Encased, Electrically Operated Screen **<Insert drawing designation>**: Motor-in-roller unit with screen case fabricated from formed-steel sheet or from aluminum extrusions with manufacturer's standard finish and matching end caps.
 1. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
 2. Controls: Remote, **[key-operated,]** three-position control switch installed in recessed device box with flush cover plate **[matching other electrical device cover plates in room where switch is installed].**
 - a. Provide with **[one control switch]** **[two control switches]** **[number of control switches indicated on Drawings]** <Insert requirements>.
 - b. Provide power supply for low-voltage systems if required.
 - c. Provide locking cover plates for switches.
 - d. Provide key-operated, power-supply switch.
 - e. Provide **[infrared]** **[radio-frequency]** remote control, consisting of battery-powered transmitter and receiver.
 - f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.
 3. Surface-Mounting Configuration: **[Mounted using manufacturer's standard projecting wall brackets]** **[Mounted directly to wall or ceiling, as indicated on Drawings, with concealed mounting]** **[Recessed in ceiling trough indicated on Drawings, with concealed mounting]** <Insert requirements>.
 4. Screen-Case Color: [As selected by Architect from manufacturer's standard options] **[White]** **[Black]** <Insert requirements>.

5. Free-Hanging, Matte Viewing Surface: [White, 1.0 minimum peak gain and 60-degree minimum half-gain angle] [White, 1.0 minimum peak gain and material does not reach half gain] [Gray, 0.8 minimum peak gain and material does not reach half gain] <Insert requirements>.
 - a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at **[top] [bottom] [location indicated on Drawings]** <Insert requirements> of viewing surface.
 - b. Edge Treatment: [Manufacturer's standard] [Black] [Without black] masking borders.
 6. Tab-Tensioned, High-Contrast-Gray Viewing Surface: Minimum peak gain of **[0.6 and 60-degree] [0.8 and 45-degree]** <Insert requirements> minimum half-gain angle **[, with black backing]**.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
 - b. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at **[top] [bottom] [location indicated on Drawings]** <Insert requirements> of viewing surface.
 7. Tab-Tensioned, Gain-White Viewing Surface: Minimum peak gain of **[1.3 and 75-degree] [1.5 and 60-degree] [1.7 and 40-degree]** <Insert requirements> minimum half-gain angle. Provide viewing surface with black backing and without seams.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
 8. Tab-Tensioned, ALR Viewing Surface: Minimum peak gain of [0.8, 57 percent ALR, and 50-degree] [1.0, 73 percent ALR, and 35-degree] [1.0, 82 percent ALR, and 18-degree] <Insert requirements> minimum half-gain angle. Provide viewing surface without seams.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
 9. Size of Viewing Surface: [As indicated in schedule on Drawings] **[50 by 80 inches] [57-1/2 by 92 inches] [87-1/2 by 140 inches] [45 by 80 inches] [52 by 92 inches] [79 by 140 inches]** <Insert dimensions>.
 10. Extra Drop Height: [As indicated in schedule on Drawings] [As needed at top of screen for bottom of screen to be **36 inches** above floor] **[36 inches** at bottom of screen] <Insert description>.
 - a. Color: [Same as viewing surface] [Black].
- C. Surface-Mounted, Wood-Finished, Electrically Operated Screen <Insert drawing designation>: Motor-in-roller unit with tab-tensioned screen; with screen case with flat back, hardwood finish, and concealed mounting brackets for surface mounting on wall or ceiling, as indicated on Drawings.
1. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.

2. Controls: Remote, [**key-operated,**] three-position control switch installed in recessed device box with flush cover plate [**matching other electrical device cover plates in room where switch is installed**].
 - a. Provide with [one control switch] [two control switches] [number of control switches indicated on Drawings] <Insert requirements>.
 - b. Provide power supply for low-voltage systems if required.
 - c. Provide locking cover plates for switches.
 - d. Provide key-operated, power-supply switch.
 - e. Provide [infrared] [radio-frequency] remote control, consisting of battery-powered transmitter and receiver.
 - f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.
3. Screen-Case Hardwood: [Oak] [Walnut] [Mahogany] [Cherry] [As selected by Architect from manufacturer's full range of species] <Insert species>.
 - a. Corners: [Radiused] [Rectilinear] [Traditional crown trim at top, rectilinear at sides and bottom] [Beveled at top, eased at sides and bottom] <Insert requirements>.
 - b. Finish: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert requirements>.
4. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
5. Matte-White Viewing Surface: [1.0 minimum peak gain; material does not reach half-gain] <Insert requirements>. Provide viewing surface [with] [without] black backing.
 - a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [top] [bottom] [location indicated on Drawings] <Insert requirements> of viewing surface.
6. High-Contrast-Gray Viewing Surface: [0.6 minimum peak gain; material does not reach half gain] <Insert requirements>. Provide viewing surface [with] [without] black backing.
 - a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [top] [bottom] [location indicated on Drawings] <Insert requirements> of viewing surface.
7. Gain-White Viewing Surface: Minimum peak gain of [1.3] [1.6] [1.8] <Insert value>; material does not reach half gain. Provide viewing surface without seams and with black backing.
8. ALR Viewing Surface: Minimum peak gain of [0.8, 57 percent ALR, and 50-degree] [0.1, 73 percent ALR, and 35-degree] [0.1, 82 percent ALR, and 18-degree] <Insert requirements> minimum half-gain angle. Provide viewing surface without seams.
9. Size of Viewing Surface: [As indicated in schedule on Drawings] [50 by 80 inches] [57-1/2 by 92 inches] [45 by 80 inches] [52 by 92 inches] <Insert dimensions>.
10. Extra Drop Height: [As indicated in schedule on Drawings] [As needed at top of screen for bottom of screen to be 36 inches above floor] [36 inches at bottom of screen] <Insert requirements>.
 - a. Color: [Same as viewing surface] [Black].

- D. Suspended, Electrically Operated Screen **<Insert drawing designation>**: Unit designed and fabricated for suspended mounting.
1. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
 2. End-Mounted Motor: Instant-reversing, gear-drive motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Locate motor in its own compartment **[on right end of screen] [on left end of screen] [on end of screen indicated on Drawings]**. Support roller with self-aligning bearings in brackets.
 3. Wiring Compartment: Metal or metal lined.
 4. Controls: Remote, **[key-operated,]** three-position control switch installed in recessed device box with flush cover plate **[matching other electrical device cover plates in room where switch is installed]**.
 - a. Provide with **[one control switch] [two control switches] [number of control switches indicated on Drawings] <Insert requirements>**.
 - b. Provide power supply for low-voltage systems if required.
 - c. Provide locking cover plates for switches.
 - d. Provide key-operated, power-supply switch.
 - e. Provide **[infrared] [radio-frequency]** remote control, consisting of battery-powered transmitter and receiver.
 - f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.
 5. Screen Case: **[Metal] [Metal and fire-retardant materials] [Metal, wood, wood products, and fire-retardant materials]**.
 - a. Ceiling Aperture: **[Open under screen compartment] [With closure, hinged to automatically open when screen is lowered and automatically close when screen is fully raised]**.
 - 1) Provide screen case **[with trim flange to receive ceiling finish] [constructed to be installed with underside flush with ceiling] [constructed to be installed with ceiling finish applied to underside]**.
 - b. Finish on Exposed Surfaces: **[Manufacturer's standard] [Prime painted] [Vinyl covering or baked enamel] <Insert requirements>**.
 6. Free-Hanging, Matte Viewing Surface: **[White, 1.0 minimum peak gain and 60-degree minimum half-gain angle] [White, 1.0 minimum peak gain and material does not reach half gain] [Gray, 0.8 minimum peak gain and material does not reach half gain] <Insert requirements>**.
 - a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at **[top] [bottom] [location indicated on Drawings] <Insert requirements>** of viewing surface.
 - b. Edge Treatment: **[Manufacturer's standard] [Black] [Without black] masking borders**.

7. Tab-Tensioned, High-Contrast-Gray Viewing Surface: Minimum peak gain of **[0.6 and 60-degree]** **[0.8 and 45-degree]** <Insert requirements> minimum half-gain angle **[, with black backing]**.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
 - b. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at **[top]** **[bottom]** **[location indicated on Drawings]** <Insert requirements> of viewing surface.
8. Tab-Tensioned, Gain-White Viewing Surface: Minimum peak gain of **[1.3 and 75-degree]** **[1.5 and 60-degree]** **[1.7 and 40-degree]** <Insert requirements> minimum half-gain angle. Provide viewing surface with black backing and without seams.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
9. Tab-Tensioned, ALR Viewing Surface: Minimum peak gain of [0.8, 57 percent ALR, and 50-degree] [1.0, 73 percent ALR, and 35-degree] [1.0, 82 percent ALR, and 18-degree] <Insert requirements> minimum half-gain angle. Provide viewing surface without seams.
 - a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
10. Size of Viewing Surface: [As indicated in schedule on Drawings] **[50 by 80 inches]** **[57-1/2 by 92 inches]** **[87-1/2 by 140 inches]** **[45 by 80 inches]** **[52 by 92 inches]** **[79 by 140 inches]** <Insert dimensions>.
11. Extra Drop Height: [As indicated in schedule on Drawings] [As needed at top of screen for bottom of screen to be **36 inches** above floor] **[36 inches** at bottom of screen] <Insert description>.
 - a. Color: **[Same as viewing surface]** **[Black]**.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install front-projection screens at locations indicated on Drawings to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor them to supporting substrate in a manner that produces a smoothly operating screen that, when lowered, has flat viewing surface and plumb vertical edges.
 1. Install low-voltage controls in accordance with NFPA 70 and complying with manufacturer's written instructions.
 - a. Wiring Method: Install wiring in raceway, except in accessible ceiling spaces and in gypsum board partitions, where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables, except in unfinished spaces.

2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

END OF SECTION

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SECTION 11 81 29

FACILITY FALL PROTECTION DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Roof safety and tieback anchors.
- B. Supplementary components and accessories necessary for a complete installation.

1.02 DELEGATED DESIGN REQUIREMENTS:

- A. Engineer, fabricate, assemble and install roof safety and tieback anchors in order to meet or exceed the performance criteria specified in Section; to conform to the profiles and spacing indicated and to other requirements of the Contract Documents; to satisfy the requirements of the authorities having jurisdiction; and to provide watertight and structurally sound assemblies capable of withstanding minimum specified performance requirements without failure.
- B. Coordinate design with University's requirements, and with the requirements and recommendations of University's consultant's, if any, prior to submitting shop drawings of final design.

1.03 REFERENCE STANDARDS

- A. ASME A120.1 - Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance 2021.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- C. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire 1995 (Reapproved 2019).

1.04 QUALITY ASSURANCE

- A. Source limitations: Obtain each type of tieback anchor used for Project through one source from the same manufacturer.
- B. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
- C. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.
- D. Regulatory Requirements.
 - 1. Comply with OSHA regulations as follows:
 - a. 1910, Subpart D, Walking and Working Surfaces.
 - b. Appendix C to 1910 Subpart F, Personal Fall Arrest Systems.

- c. OSHA Ruling on Window Cleaning by Bosun's Chair.
- d. 1910.66, Subpart F, Powered Platforms.
- 2. Comply with California State regulations as follows:
 - a. Code of Regulations, Title 8 - Industrial Relations, Article 5 (Window Cleaning), Article 6 (Powered Platforms for Exterior Building Maintenance), and Appendix C to Article 6 (Personal Fall Arrest System).

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original packaging with identification labels intact and in sizes to suit project
- B. Do not store fall restraint system in contact with other materials that might cause staining, denting, or other surface damage. Store fall restraint system away from uncured concrete and masonry.
- C. Store manufactured units off the ground or floor on pallets, and protected from precipitation or other forms of moisture with breathing-type covers. Un-vented polyethylene tarpaulins are not permitted.
- D. Provide spacers to separate stored items and to provide air circulation around all surfaces.
- E. Protect stored items to prevent contact with wet or damp surfaces, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
- F. Store manufactured units in a manner to prevent bending, warping, twisting or other physical damage.
- G. At no cost to the University, remove and replace corroded, deteriorated, stained, or damaged units from the Project site.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Design fall restraint system to suit project requirements to AISC S342L and as indicated.
- B. Locate anchorages to suit suspension equipment specified.
- C. Design anchor components for cleaning and suspended maintenance equipment to ASME A120.1.
 - 1. Ensure compatibility with industry standard equipment.
 - 2. Anchorage and anchor components: Designed by Engineer qualified in design of window cleaning and suspended maintenance equipment and licensed in state where project is located.
- D. Design system fall arrest safety anchors and equipment supports to AISC S342L (including supplement No.1) and ANSI/IWCA I-14.1, and as follows:
 - 1. Comply with OSHA 1910, Subpart F, Appendix C.
 - 2. Fall Arrest Safety Anchors:
 - a. Fall arresting force safety factor of 2 to 1 without permanent deformation: 1,800 lbs minimum.

- E. Fall arrest force against fracture or detachment: 5,000 lbs minimum.

2.02 ANCHORS

- A. Roof Anchor: Galvanized steel post with eye hook and 1/2 inch thick galvanized steel base plate.
- B. Roof Anchor: 1/2 inch thick galvanized steel base plate.with eye hook.
- C. Safety Anchor Eye Plate: Mild steel, Type 300W with 44 ksi minimum yield strength, hot-dip galvanized to ASTM A123/A123M.
 - 1. Plate: 7/8 inch diameter material with 2 inch eye opening.
- D. Hollow Steel Section (HSS) Piers: Mild steel, Type 300W with 50 ksi minimum yield strength, hot dipped galvanized to ASTM A123/A123M.
 - 1. Wall thickness to suit application.
- E. Plate and other Sections: Mild steel, Type 300W with 44 ksi minimum yield strength, hot dipped galvanized to ASTM A123/A123M or manufacturer's polyurethane/polyurea coating system.
 - 1. Wall thickness to suit application.
- F. Miscellaneous Bolts, Nuts and Washers: Stainless steel to ASTM A276, Type 304 with 35 Ksi (240 MPa) minimum yield strength.

2.03 HORIZONTAL CABLE TIE-OFF SYSTEM

- A. Stainless steel to ASTM A492, Type 316, 5/16 inch minimum diameter cable, 9127 lbs (40 kN) minimum breaking strength with permanently swedged cable ends.
- B. Data plate: Ensure non-corrosive data plate stating Maximum Service Capacity of cable, Manufacturer's Name, Serial No., Manufacturing Date, rated load and other pertinent information is prominently displayed at cable system entry points.
- C. Tensioner: Stainless steel turnbuckle to ASTM A167, Type 316.

2.04 ACCESSORIES

- A. Pier/base plate assembly: Steel tube continuously welded to steel base plate and galvanized after fabrication.
- B. Safety Anchor Eye Plate: Mild steel, Type 300W with 44 Ksi minimum yield strength, hot-dip galvanized to ASTM A123/A123M.
 - 1. Plate: 0.875 inches diameter material with 2 inches eye opening.
- C. Hollow Steel Section (HSS) Piers: Mild steel, Type 300W with 50 Ksi minimum yield strength, hot dipped galvanized to ASTM A123/A123M.
 - 1. Wall thickness to suit application.
- D. Plate and other sections: Mild steel, Type 300W with 44 Ksi minimum yield strength, hot dipped galvanized to ASTM A123/A123M.
 - 1. Wall thickness to suit application.
- E. Miscellaneous Bolts, Nuts and Washers: Mild steel, Type 300W with 44 Ksi minimum yield strength, hot-dip galvanized to ASTM A123/A123M minimum yield strength.

- F. Other Accessories: Install or apply other accessories and similar secondary items supplied, required, recommended, approved, or accepted by the expansion joint assembly manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine adjacent construction and supports.
- B. Verify that substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of roof tie back equipment.
- C. Inform Design Build Architect of unacceptable conditions immediately upon discovery.
- D. Correct conditions detrimental to the proper and timely completion of the Work before proceeding with installation.

3.02 INSTALLATION

- A. Install fall protection equipment in compliance with manufacturer's instructions.
- B. Fasten anchors in accordance with manufacturer's recommendations
- C. Accurately fit and align, securely fasten and install free from distortion or defects
- D. Deform threads of tail end of anchor studs after nuts have been tightened to prevent accidental removal or vandalism.
- E. Securely fasten roof accessories in place, using fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation.
- F. Seal joints with elastomeric sealant as recommended or approved by roof safety and tieback anchors and roofing membrane manufacturers.
- G. At no cost to the University, either correct deficiencies that do not comply with specified requirements, as determined by the manufacturer and Design Build Architect, or remove, repair substrates and reinstall roof safety and tieback anchors that cannot be satisfactorily repaired, as determined and directed by the manufacturer's field representative and the Design Build Architect.

3.03 FIELD QUALITY CONTROL

- A. Request site attendance of manufacturer technical representative at the beginning of installation operations.
- B. Have manufacturer's technical representative schedule site visits to review work as follows:
 - 1. When preparatory work for which work of this Section depends is complete, but before installation begins.
 - 2. 2 times during progress of work at 25% and 60% of completion.
 - 3. Upon completion of work, after cleaning is carried out.
- C. Testing: Test on site 100% of anchors relying upon chemical adhesive fasteners using load cell test apparatus in accordance with manufacturer's written recommendations.

3.04 PROTECTION

- A. Protect units in place during the construction period against corrosion, deterioration, staining or other damage until acceptance by the University.

END OF SECTION

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DIVISION 12

FURNISHINGS

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SECTION 12 24 13
ROLLER WINDOW SHADES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Motor-operated, single-roller shades.
2. Motor-operated, double-roller shades.
3. Motor-operated, skylight roller shades.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.02 ALLOWANCES

- A. Roller shades are part of [Window-Covering Allowance] <Insert name of allowance>.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
2. Concealed recessed pocket.
3. Black out shades.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Samples for Initial Selection: For each type and color of shadeband material.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than **[10 inches] [3 inches]** square. Mark interior face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.

3. Installation Accessories: Full-size unit, not less than 10 inches long.

F. Product Schedule: For roller shades. [Use same designations indicated on Drawings.]

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

C. Product Test Reports: For each type of shadeband material, for tests performed by [manufacturer and witnessed by a qualified testing agency] [a qualified testing agency].

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than **[two]** <Insert number> units.

1.07 QUALITY ASSURANCE

A. Roller Window Shades intended for occupant use must have accessible controls.

B. Installer Qualifications: Fabricator of products.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.09 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain roller shades from single source from single manufacturer.

2.02 MANUFACTURERS

- A. Products: See current Campus Specification Matrix for Preferred Manufacturers.

2.03 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 - 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Electric Motor: **[Manufacturer's standard]** <Insert description> tubular, enclosed in roller.
 - a. Electrical Characteristics: **[110-V ac]** **[220-V ac]** **[24-V dc]** **[12-V dc]** **[Solar-powered dc]** <Insert requirements>.
 - b. Maximum Total Shade Width: **[As required to operate roller shades indicated]** <Insert requirements>.
 - c. Maximum Shade Drop: **[As required to operate roller shades indicated]** <Insert requirements>.
 - d. Maximum Weight Capacity: **[As required to operate roller shades indicated]** <Insert requirements>.
 - 3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for **[surface]** **[recessed or flush]** <Insert type> mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, **[maintained]** **[momentary]**-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - b. Individual Switch Control Station: **[Maintained]** **[Momentary]**-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: **[Three]** **[Five]**.
 - 2) Switch Style: **[Toggle]** **[Rocker]**.

- c. Group Control Station: **[Maintained] [Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - d. Individual/Group Control Station: **[Maintained] [Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - e. Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.
 - f. Infrared Control: System consisting of concealed receiver complete with external eye and connecting modular cable and **[two] <Insert number>** portable, multiple-channel transmitters with separate buttons to open and close individual or groups of shades, to open and close shades simultaneously, and to stop shade movement.
 - 1) Capacity: Up to **[12] <Insert number>** individual or groups of shades.
 - g. Timer Control: Clock timer, **[24-hour] [seven-day] <Insert period>** programmable for regular events.
 - h. Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.
 - i. Color: **[As selected by Architect from manufacturer's full range] <Insert color>**.
 - 4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
 - 5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
 - 6. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Capable of interface with **[audiovisual] [multiroom] <Insert description>** control system.
 - c. Capable of accepting input from building automation control system.
 - d. Override switch.
 - 7. Accessories:
 - a. **<Insert accessory>**.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
- 1. Roller Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.
 - 2. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
 - 3. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.

- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
- E. Shadebands:
1. Shadeband Material: [Light-filtering fabric] [Light-blocking fabric] <Insert requirements>.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: [Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal at bottom where it meets the sill] <Insert description>.
 - b. Color and Finish: [As selected by Architect from manufacturer's full range] <Insert color and finish>.
- F. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: [L-shaped] [Curved] <Insert requirements>.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[4 inches] [3 inches] <Insert dimension>**.
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[4 inches] [3 inches] [as indicated on Drawings] <Insert dimension>**.
 3. Endcap Covers: To cover exposed endcaps.
 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[6 inches] [5 inches] [4 inches] [height indicated on Drawings] <Insert dimension>**.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
 5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: [As indicated on Drawings] **[2 inches] <Insert dimension>**.
 6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
 7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.

8. Installation Accessories Color and Finish: [As selected from manufacturer's full range] <Insert color and finish>.

2.04 MOTOR-OPERATED, DOUBLE-ROLLER SHADES

A. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: **[Manufacturer's standard]** <Insert description> tubular, enclosed in rollers.
 - a. Electrical Characteristics: [110-V ac] [220-V ac] [24-V dc] [12-V dc] [Solar-powered dc] <Insert requirements>.
 - b. Maximum Total Shade Width: [As required to operate roller shades indicated] <Insert requirements>.
 - c. Maximum Shade Drop: [As required to operate roller shades indicated] <Insert requirements>.
 - d. Maximum Weight Capacity: [As required to operate roller shades indicated] <Insert requirements>.
3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for **[surface]** **[recessed or flush]** <Insert type> mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, **[maintained]** **[momentary]**-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - b. Individual Switch Control Station: **[Maintained]** **[Momentary]**-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: **[Three]** **[Five]**.
 - 2) Switch Style: **[Toggle]** **[Rocker]**.
 - c. Group Control Station: **[Maintained]** **[Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - d. Individual/Group Control Station: **[Maintained]** **[Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - e. Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.
 - f. Infrared Control: System consisting of concealed receiver complete with external eye and connecting modular cable and **[two]** <Insert number> portable, multiple-channel transmitters with separate buttons to open and close individual or groups of shades, to open and close shades simultaneously, and to stop shade movement.
 - 1) Capacity: Up to **[12]** <Insert number> individual or groups of shades.

- g. Timer Control: Clock timer, **[24-hour] [seven-day] <Insert period>** programmable for regular events.
 - h. Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.
 - i. Color: **[As selected by Architect from manufacturer's full range] <Insert color>**.
 - 4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
 - 5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.
 - 6. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Capable of interface with **[audiovisual] [multiroom] <Insert description>** control system.
 - c. Capable of accepting input from building automation control system.
 - d. Override switch.
 - 7. Accessories:
 - a. **<Insert accessory>**.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.
 - 1. Double-Roller Mounting Configuration: **[Side by side] [Offset, outside shade over and inside shade under] <Insert requirements>**.
 - 2. Inside Roller:
 - a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.
 - b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
 - 3. Outside Roller:
 - a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.
 - b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
 - 4. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Inside Shadebands:

1. Shadeband Material: [Light-filtering fabric] <Insert requirements>.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: [Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] <Insert description>.
 - b. Color and Finish: [As selected by Architect from manufacturer's full range] <Insert color and finish>.
- F. Outside Shadebands:
1. Shadeband Material: [Light-blocking fabric] <Insert requirements>.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: [Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal where bottom (sill) channels are indicated] <Insert description>.
 - b. Color and Finish: [As selected by Architect from manufacturer's full range] <Insert color and finish>.
- G. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: [L-shaped] [Curved] <Insert requirements>.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[4 inches] [3 inches] <Insert dimension>**.
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[4 inches] [3 inches] [as indicated on Drawings] <Insert dimension>**.
 3. Endcap Covers: To cover exposed endcaps.
 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[6 inches] [5 inches] [4 inches] [height indicated on Drawings] <Insert dimension>**.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
 5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recesses or pockets and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: [As indicated on Drawings] **[2 inches] <Insert dimension>**.
 6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
 7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.

8. Installation Accessories Color and Finish: [As selected from manufacturer's full range] <Insert color and finish>.

2.05 MOTOR-OPERATED, SKYLIGHT ROLLER SHADES

- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 1. System Type: [Double-roller, two-motor system, one for shadeband roll-up, one for cable take-up] [Single-motor, double-roller system, with motor in drive roller and spring in take-up roller] [Single motor and roller, gravity drop] <Insert description>.
 2. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Electric Motor: **[Manufacturer's standard]** <Insert description> tubular, enclosed in roller.
 - a. Electrical Characteristics: [110-V ac] [220-V ac] [24-V dc] [12-V dc] [Solar-powered dc] <Insert requirements>.
 - b. Maximum Total Shade Width: [As required to operate roller shades indicated] <Insert requirements>.
 - c. Maximum Shade Length: [As required to operate roller shades indicated] <Insert requirements>.
 - d. Maximum Weight Capacity: [As required to operate roller shades indicated] <Insert requirements>.
 4. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for **[surface]** **[recessed or flush]** <Insert type> mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, **[maintained]** **[momentary]**-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - b. Individual Switch Control Station: **[Maintained]** **[Momentary]**-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: **[Three]** **[Five]**.
 - 2) Switch Style: **[Toggle]** **[Rocker]**.
 - c. Group Control Station: **[Maintained]** **[Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - d. Individual/Group Control Station: **[Maintained]** **[Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - e. Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.

- f. Infrared Control: System consisting of concealed receiver complete with external eye and connecting modular cable and **[two] <Insert number>** portable, multiple-channel transmitters with separate buttons to open and close individual or groups of shades, to open and close shades simultaneously, and to stop shade movement.
 - 1) Capacity: Up to **[12] <Insert number>** individual or groups of shades.
- g. Timer Control: Clock timer, **[24-hour] [seven-day] <Insert period>** programmable for regular events.
- h. Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.
- i. Color: **[As selected by Architect from manufacturer's full range] <Insert color>**.
5. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
6. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.
7. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Capable of interface with **[audiovisual] [multiroom] <Insert description>** control system.
 - c. Capable of accepting input from building automation control system.
 - d. Override switch.
8. Accessories:
 - a. **<Insert accessory>**.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.
 2. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
 3. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] <Insert description>**.
- C. Shadeband Retention System: Manufacturer's standard system for guiding shadeband through range of travel and holding shadeband taut with edges of shadeband supported by side channels or angles.
- D. Mounting Hardware: Corrosion resistant and compatible with operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
 1. Shadeband Material: **[Light-filtering fabric] [Light-blocking fabric] <Insert requirements>**.

2. Shadeband Bottom (Hem) Bar: Manufacturer's standard for operating mechanism indicated.
 - a. Color and Finish of Exposed Bottom Bar: [As selected by Architect from manufacturer's full range] <Insert color and finish>.

F. Installation Accessories:

1. Exposed Headboxes and Bottom Boxes: Rectangular, extruded-aluminum enclosure including front fasciae, top and back covers, endcaps, and removable closures.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[height indicated on Drawings]** <Insert dimension>.
2. Channels or Angles: Manufacturer's standard design for operating mechanism indicated and shadeband take-up and support.
3. Installation Accessories Color and Finish: [As selected from manufacturer's full range] <Insert color and finish>.

2.06 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with **[NFPA 701]** <Insert requirement>. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: [Roller shade manufacturer] <Insert source for custom fabrics>.
 2. Type: [PVC-coated fiberglass] [PVC-coated polyester] [Woven PVC-coated fiberglass and PVC-coated polyester] [Woven polyester and PVC-coated polyester] [Acrylic-coated fiberglass] [PVC-coated fiberglass with silver backing] <Insert description>.
 3. Weave: [Mesh] [Basketweave] <Insert description>.
 4. Thickness: <Insert thickness>.
 5. Weight: <Insert oz./sq. yd. >.
 6. Roll Width: **[36 inches]** **[48 inches]** **[60 inches]** **[72 inches]** **[84 inches]** <Insert dimension>.
 7. Orientation on Shadeband: [Up the bolt] [Railroaded] [As indicated on Drawings] <Insert requirements>.
 8. Openness Factor: **[1]** **[3]** **[5]** **[10]** **[11]** **[22]** <Insert number> percent.
 9. Color: [As indicated on Drawings] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 1. Source: [Roller shade manufacturer] <Insert source for custom fabrics>.
 2. Type: [Fiberglass textile with PVC film bonded to both sides] [Fiberglass with acrylic backing] [Acrylic-coated fiberglass] [Polyester-cotton blend] [Polyester with foamed-acrylic backing] [PVC-coated fiberglass with bonded PVC film] <Insert description>.
 3. Thickness: <Insert thickness>.
 4. Weight: <Insert oz./sq. yd. >.

5. Roll Width: **[36 inches] [48 inches] [60 inches] [72 inches] [84 inches]** <Insert dimension>.
6. Orientation on Shadeband: **[Up the bolt] [Railroaded] [As indicated on Drawings]** <Insert requirements>.
7. Features: **[Washable] [Antistatic treatment]** <Insert requirements>.
8. Color: **[As indicated on Drawings] [Match Architect's sample] [As selected by Architect from manufacturer's full range]** <Insert color>.

2.07 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than **[1:4] <Insert ratio>**, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 2. Skylight Shades: Provide battens and seams at uniform spacings along shadeband as required to ensure shadeband tracking and alignment through its full range of movement without distortion or sag of material.
 3. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, **[locations of connections to building electrical system,]** and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than **[2 inches] <Insert dimension>** to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: **[At exterior windows] [As indicated in window-covering schedule] [As indicated on Drawings] <Insert requirements>**.

3.03 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.04 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

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SECTION 12 36 00

COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.

1.02 REFERENCE STANDARDS

- A. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications 2022.
- B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- D. NAAWS - North American Architectural Woodwork Standards 2021, with Errata.
- E. ISFA 2-01 - Classification and Standards for Solid Surfacing Material 2013.
- F. NAAWS (CCP) - Certified Compliance Program (CCP) Current Edition.
- G. NAAWS (CSIP) - Certified Seismic Installation Program (CSIP) Current Edition.

1.03 ACTION SUBMITTALS

- A. Product Data: For countertop materials [and sinks].
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.
 - 2. Wood trim, 8 inches long.
 - 3. One full-size solid surface material countertop, with front edge [and backsplash], 8 by 10 inches, of construction and in configuration specified.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: To include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- B. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a licensee of NAAWS 's Certified Compliance Program.
 - 1. Quality Certification: Comply with NAAWS (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section.
 - 2. Comply with NAAWS (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org.
 - 3. Comply with NAAWS (MCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.woodworkinstitute.com.
 - 4. Provide labels or certificates indicating that the installed work complies with NAAWS requirements for grade or grades specified.
 - 5. Provide designated labels on shop drawings as required by certification program.
 - 6. Provide designated labels on installed products as required by certification program.
 - 7. Replace, repair, or rework all work for which certification is refused.
- C. Fabrication and Installation Standards: Fabricate and install in accordance with North American Architectural Woodwork Standards – 3.0 as listed below.
 - 1. Countertops: Section 11.
- D. North American Architectural Woodwork Standards (NAAWS) Certification:
 - 1. Millwork, casework and cabinetwork shall be manufactured in accordance with standards established in the NAAWS, Latest Edition, in grade or grades herein specified or as shown on Drawings.
 - 2. Before delivery to jobsite, woodwork supplier shall submit NAAWS Certified Compliance Certificate indicating millwork products being supplied and certifying that products fully meet the requirements of Grade or Grades specified.
 - 3. At completion of installation, woodwork installer shall provide NAAWS Certified Compliance Certificate indicating the products installed, and certifying that the installation of these products fully meets the requirements of the Grade or Grades specified.
 - 4. All fees charged by the NAAWS for their Certified Compliance program are responsibility of millwork manufacturer and/or installer and shall be included in their bid.
 - 5. The foregoing shall not be construed to limit power and authority of University to reject any millwork which does not in University's opinion meet with any one or more of the specifications of this Contract.

1.07 MOCK-UPS

- A. Mock-ups: Build mock-ups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mock-ups of typical countertops as indicated on Drawings.
 - 2. Subject to compliance with requirements, approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.09 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 deg F and 90 degrees F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.
- D. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.10 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide products by one of the following:
 - 1. Arizona Tile
 - 2. Caesarstone.
 - 3. Formica.
 - 4. Wilsonart.
 - 5. Lapitec, silica free product.
- B. See current Campus Specification Matrix for Preferred Manufacturers.

2.02 COUNTERTOPS

- A. Quality Standard: Premium Grade, in accordance with NAAWS, unless noted otherwise.
- B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - b. NSF approved for food contact.
 - 3. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
 - 4. Exposed Edge Treatment: As indicated on Drawings.
 - 5. Back Splashes: Same sheet material, square top; minimum 4 inches high.
 - 6. Fabricate in accordance with NAAWS, Section 11 - Countertops, Premium Grade.
 - 7. Silica free products are preferred.
- C. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI SS1.
 - 1. Configuration: Provide countertops with the following front and backsplash style:
 - a. Front: Straight, slightly eased at top.
 - b. Backsplash: Straight, slightly eased at corner.
 - c. Countertops: 1/2 inch thick, quartz agglomerate with front edge built up with same material.
 - 2. Backsplashes: 1/2 inch thick, quartz agglomerate.
 - 3. Fabrication: Fabricate tops in one piece with shop-applied edges unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - a. Fabricate with loose backsplashes for field assembly.

2.03 ACCESSORY MATERIALS

- A. Wood-Based Components:
 - 1. Wood fabricated from old growth timber is not permitted.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
 2. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
 3. Softwood Plywood: DOC PS 1.
- C. Composite wood products within the weatherproofing membrane must be documented to have low formaldehyde emissions that meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins (NAUF).
- D. Documentation: manufacturer documentation which confirms low formaldehyde emissions that meet the California Air Resources Board Composite Wood Products Airborne Toxic Control Measures (ATCM) for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins (NAUF).
- E. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
1. Adhesives shall have a VOC content of 70 g/L or less
 2. Adhesives shall meet VOC and chemical component limits of South Coast Air Quality Management District SCAQMD 1168 and CAL-Green Table 5.504.4.1 Adhesive VOC Limit requirements.
- F. Joint Sealant: As specified in Section 07 92 00 - Joint Sealants.
- G. Grommets for Cable Passage: Standard plastic or painted metal, 2 inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Color: Black.
- H. Counter Support Brackets.

2.04 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back splash wherever counter edge abuts vertical surface unless otherwise indicated.
1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height and Location: As indicated on Drawings.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

- D. Quartz Agglomerate: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Design Build Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 1. Install backsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 2. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- C. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- D. Attach stainless steel countertops using stainless steel fasteners and clips.
- E. Seal joint between back/end splashes and vertical surfaces.

3.03 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.04 CLEANING

- A. Clean countertops surfaces thoroughly.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

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SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Roll-up rail mats.
2. Resilient entrance mats.
3. Resilient-tile entrance mats.
4. **[Recessed] [Surface-mounted] frames.**

B. Related Requirements:

1. Section 12 48 16 "Entrance Floor Grilles" for rigid floor grilles and frames.

1.03 COORDINATION

- A. Coordinate size and location of recesses in concrete to receive floor mats and frames.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.

B. Shop Drawings:

1. Items penetrating floor mats and frames, including door control devices.
2. Divisions between mat sections.
3. Perimeter floor **[moldings] [frames]**.
4. Custom Graphics: Scale drawing indicating colors.

C. Samples: For the following products, in manufacturer's standard sizes:

1. Floor Mat: Assembled sections of floor mat.
2. Tread Rail: Sample of each type and color.
3. Frame Members: Sample of each type and color.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For floor mats and frames to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Resilient-Tile Entrance Mats: Full-size tile units equal to **[2]** <Insert number> percent of amount installed, but no fewer than **[10]** <Insert number> units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tandus, or Equal.
- B. See current Campus Standards for Preferred Manufacturers.

2.02 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

- A. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
1. Uniform floor load of **[300 lbf/sq. ft.]** <Insert value>.
 2. Wheel load of **[350 lb]** <Insert value> per wheel.
- B. Accessibility Standard: Comply with applicable provisions in **[the DOJ's "2010 ADA Standards for Accessible Design"]** **[and]** **[ICC A117.1]** <Insert regulation>.

2.03 ROLL-UP RAIL MATS

- A. Roll-up, Aluminum-Rail Hinged Mats: Extruded-aluminum tread rails **[1-1/2 inches]** **[2 inches]** <Insert dimension> wide by 3/8 inch thick, sitting on continuous vinyl cushions.
1. Tread Inserts: **[Plain serrated aluminum treads]** **[Textured-surface, resilient vinyl]** **[Ribbed-design-surface, resilient vinyl]** **[Mineral abrasive particles bonded to or embedded in vinyl]** **[Aluminum-oxide or silicon-carbide grit in epoxy matrix]** **[1/4-inch-high, 28-oz./sq. yd. weight, level-cut, nylon-pile, fusion-bonded carpet]** <Insert tread inserts>.
 2. Colors, Textures, and Patterns of Inserts: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
 3. Rail Color: **[Mill finish]** **[Clear]** **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]**.
 4. Hinges: **[Plastic]** **[Aluminum]**.
 5. Mat Size: **[As indicated]** <Insert size>.
- B. Roll-up, Vinyl-Rail Hinged Mats: Vinyl-acrylic tread rails **[1-1/2 inches]** **[2 inches]** <Insert dimension> wide by 3/8 inch thick, with slotted or perforated hinges.
1. Tread Inserts: **[Textured-surface, resilient vinyl]** **[Ribbed-design-surface, resilient vinyl]** **[Mineral abrasive particles bonded to or embedded in vinyl]** **[Aluminum-oxide or silicon-carbide grit in epoxy matrix]** **[1/4-inch-high, 28-oz./sq. yd. weight, level-cut, nylon-pile, fusion-bonded carpet]** <Insert tread inserts>.

2. Colors, Textures, and Patterns of Inserts: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
3. Rail Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
4. Hinges: [Vinyl] [Aluminum].
5. Mat Size: [As indicated] <Insert size>.

2.04 RESILIENT ENTRANCE MATS

- A. Resilient Link Mats: Reversible [vinyl] [rubber] [rubber-tire] link mats, [3/8 inch] [or] [7/16 inch] thick, with [galvanized-spring] [stainless]-steel wire link rods, vulcanized edge-nosing trim, steel-reinforced end trim, and links consisting of rectangular units or continuous strips in a [heel-proof, solid-weave pattern with no openings between links] [heel-proof, close-weave pattern with openings between links not exceeding 1/8 inch wide by 1 inch long] [open-weave pattern].
 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 2. Mat Size: [As indicated] <Insert size>.
- B. [Rubber] [or] [Vinyl] Mats: [1/4-inch-] [3/8-inch-] [7/16-inch-] [1/2-inch-] <Insert dimension> thick mats; with [square edges for recessed installations] [beveled edges for surface applications] and with [solid-sheet (no perforations) style] [perforated style, 1/4-inch diameter on standard spacing] [perforated style, 3/16 by 3/4 inch on standard spacing], [standard pyramid design] [standard wide-wale corrugated] [hi-rib, narrow-wale corrugated] top profile, and [low-rib, narrow-wale corrugated] [standard knob-base] [flat-base] bottom surface.
 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 2. Mat Size: [As indicated] <Insert size>.
- C. Cocoa Mats: Constructed from cocoa fiber yarn permanently bonded to PVC backing for dimensional stability and resistance to shedding; [5/8- to 3/4-inch overall thickness; 1.5-lb/sq. ft.] [1-inch overall thickness; 2.0-lb/sq. ft.] [1-1/4-inch overall thickness; 2.5-lb/sq. ft.] weight.
 1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 2. Mat Size: [As indicated] <Insert size>.
- D. Rubber-Tire Mats: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form 3/8- to 7/16-inch-thick, 12-inch-wide, continuous linear strip up to 25 feet long.
 1. Mat Size: [As indicated] <Insert size>.
- E. Carpet-Type Mats: [Nylon] [Polypropylene] [Olefin] [Polyester] carpet bonded to 1/8- to 1/4-inch-thick, flexible vinyl backing to form mats 3/8 or 7/16 inch thick with nonraveling edges.
 1. Colors, Textures, and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 2. Mat Size: [As indicated] <Insert size>.

- F. Loop Filament Mats: Loop filament vinyl material **[3/8 inch]** **[1/2 inch]** thick, with **[solid vinyl]** **[foam]** sheet backing and with built-in chemical agents to reduce fungus and mildew.
 - 1. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
 - 2. Mat Size: **[As indicated]** <Insert size>.
- G. Graphics: Custom inlaid or woven-in graphic **[design,]** **[logo,]** **[emblem,]** **[characters,]** as indicated.

2.05 RESILIENT-TILE ENTRANCE MATS

- A. Rubber-Tire Tiles: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form 3/8- to 7/16-inch-thick, square tile.
 - 1. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
 - 2. Tile Size: **[12 inches]** **[As indicated]** <Insert size>.
- B. **[Rubber]** **[or]** **[Vinyl]** Tiles: **[5/8-inch-]** **[7/16-inch-]** thick, **[solid]** **[open-grid]** **[rubber]** **[or]** **[vinyl]** compound molded tiles with **[concealed interlocking joint tabs]** **[1/4-inch-deep]**, serpentine-grooved top face and knob-base back face on solid tile.
 - 1. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
 - 2. Tile Size: **[As indicated]** <Insert size>.
- C. Carpet-Type Tiles: **[Nylon]** **[Polypropylene]** **[Olefin]** **[Polyester]** carpet bonded to 1/8- to 1/4-inch-thick, flexible vinyl backing to form mats 3/8 or 7/16 inch thick with nonraveling edges.
 - 1. Colors, Textures, and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
 - 2. Tile Size: **[As indicated]** <Insert size>.

2.06 FRAMES

- A. Recessed Frames: Manufacturer's standard extrusion.
 - 1. Extruded Aluminum: ASTM B221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
 - a. Color: **[Mill finish]** **[Clear]** **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]**.
 - 2. Architectural Bronze: ASTM B455, Alloy UNS No. C38500.
- B. Surface-Mounted Frames:
 - 1. Tapered Frames: Tapered **[flexible vinyl edge-]** **[aluminum]** frame members, not less than **[2 inches]** **[1-1/2 inches]** wide **[, attached to mat at all four edges,]** with welded mitered corners.
 - a. Vinyl Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.

- b. Aluminum Color: [Mill finish] [Clear] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].

2.07 CONCRETE FILL AND GROUT MATERIALS

- A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.08 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
- B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
 - 1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
- C. Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and postinstalled expansion anchors.
- D. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

2.09 ALUMINUM FINISHES

- A. Mill finish.
- B. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- C. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.

2.10 COPPER-ALLOY (BRONZE) FINISHES

- A. Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finishes, as defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
- B. CDA Mechanical Finish Designation: [M11, specular, as fabricated] [M32, directionally textured, medium satin].

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, **[minimum recess depth,]**and other conditions affecting installation of floor mats and frames.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install recessed mat frames and mats to comply with manufacturer's written instructions so that tops of mats will be flush with adjoining finished flooring. Set mats with tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.
 - 1. For installation in terrazzo flooring areas, allow for grinding and polishing of terrazzo without grinding surface of recessed frames. Coordinate with other trades as required.
 - 2. Install necessary shims, spacers, and anchorages for proper location, and secure attachment of frames.
 - 3. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.
 - 4. Delay setting mats until construction traffic has ended.
- B. Install surface-type units to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.
 - 1. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.

3.03 PROTECTION

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION

SECTION 12 65 00
MULTI-USE FIXED SEATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fixed, upholstered theater chairs.
- B. Support standards.
- C. Chair accessories.

1.02 QUALITY ASSURANCE

- A. Fire Retardance of Upholstered Seating: Self-extinguishing when mock-up is exposed to smoldering cigarettes in accordance with ASTM E1352 or NFPA 261.
- B. Fire Retardance of Fixed Theater Seating: Maximum instantaneous net peak rate of heat release of 250 kW or less, and total energy released during first 5 minutes of 40 MJ or less, when tested in accordance with ASTM E1537.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver seats to project site in unopened containers clearly labeled with manufacturer's name and identification of contents.
- B. Store seating units in dry and clean location until needed for installation. During installation, handle in a manner that will prevent marring and soiling of finished surfaces.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sheet Steel: ASTM A879/A879M, Commercial Steel (CS) or Drawing Steel (DS) electrogalvanized sheet, 04Z (12G) coating class on both surfaces; chemically treated for baked enamel finish.
- B. Exposed Hardwood: Solid lumber selected for absence of visible defects; birch, northern hard maple, white oak, or species standard with manufacturer.
- C. Hardwood Plywood: HPVA HP-1; face veneers for exposed surfaces Grade A birch, hard maple, walnut, or as standard with manufacturer, with no visible defects; concealed surface veneers of sound grade hardwood.
- D. Laminated Plastic: NEMA LD 3, Type 1, Grade GP 50, nominal thickness 0.050 in; colors and patterns as selected from manufacturer's standards.
- E. Fiberglass: Molded plastic material with not less than 30 percent glass fiber reinforcement and integral color pigments.

- F. Polyurethane Foam: Density not less than 1.8 lb/cu ft, fire retardant, non-hardening and non-oxidizing, with high resistance to alkalis, oils, moisture, and mildew.
- G. Upholstery Fabric: ASTM D3597 heavy-duty plain woven nylon fabric, treated to resist cigarette ignition and staining; color and pattern as selected from manufacturer's standards.

2.02 UPHOLSTERED CHAIRS

- A. Fixed seating system designed to permit radial installation using common middle support standards in each row and aisle standards aligned as indicated on Drawings. Width of seats not less than 22 inches, except exit seat locations may be reduced to 20 inches to complete specific row dimensions.
- B. Backs: Fixed type; two-panel construction with fabric covering over padding and protective back panel, with installed height not less than 32 inches above finished floor.
 - 1. Rear Panel: One-piece molded plywood, not less than 1/4 in thick, with exposed back surface of plastic laminate.
- C. Seats: Hinged type, constructed to permit reupholstering without removing seat from chair.
 - 1. Steel Seat Construction: One-piece sheet steel pan construction, reinforced at stress points and designed to completely enclose hinges and self-rising seat mechanism; supporting not fewer than 16 coil springs or five non-sag serpentine springs. Separate padding from springs with burlap sheeting cemented to polyurethane foam padding formed with minimum thickness of 1-3/4 in. Upholster with fabric sewn into box construction without welts and securely fastened to supporting frame to provide smooth, wrinkle-free surface.

For serpentine spring construction, provide not less than 3 in thick foam padding at front edge of seat.

- D. Arm Rests: Locate at aisles and between chairs; mount to support standard with concealed fasteners; exposed surfaces of solid hardwood lumber with smoothed edges.
- E. End Panels: One piece panels fastened securely to aisle standards with concealed fasteners, configured as follows:
 - 1. Shape: Rectangular.
 - 2. Finish: Plastic laminate.

2.03 STANDARDS

- A. Support Standards: Tubular steel with welded mounting points for backs, seats, and arm rests, and welded floor anchor plates.

2.04 ACCESSORIES

- A. Folding Tablet Arms: At standard to right side of each seat, provide manufacturer's standard fold-away tablet arm assembly, with hinge and swivel mechanism securely fastened to underside of writing surface and designed to provide solid support in the open position and semi-automatic return to stowed position beneath right arm rest and parallel to right standard.
- B. At least five percent of aisle seats (but not less than one) are required to either have no armrest on the aisle side or to have a removable or folding armrest on the aisle side. These seats shall be the aisle seats located closest to accessible routes and shall be identified by a sign or marker with the International Symbol of Accessibility.

2.05 FINISHES

- A. Ferrous Metals: Manufacturer's standard two-coat baked enamel finish, applied over conversion coating appropriate to base metal.
- B. Hardwood: Manufacturer's standard clear low-gloss finish.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's installation instructions and approved shop drawings.
- B. Anchor support standards securely to substrate with at least two anchoring devices recommended by manufacturer.
 - 1. Place standards in each row laterally so the standards at the aisle will be in alignment. Vary width of seats and backs as required to optimize sightlines, and comply with the ADA Standards for Accessible Design requirements for row and aisle widths.

END OF SECTION

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DIVISION 14

CONVEYING EQUIPMENT

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SECTION 14 21 23

MACHINE ROOM ELECTRIC TRACTION ELEVATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Electric traction elevators.
- B. Related Requirements:
 - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
- 2. Section 05 50 00 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
 - e. Pit ladders.

1.02 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Electric traction elevators.
- B. Product Data Submittals: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
 - 2. Include large-scale layout of car-control station [**and standby power operation control panel**].

3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- D. Samples for Initial Selection: For finishes involving color selection.
 - E. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch-square Samples of sheet materials; and 4-inch lengths of running trim members.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Seismic Qualification Data: Certificates, for elevator equipment, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service **[including standby power generator]**, as shown and specified, are adequate for elevator system being provided.
 - D. Sample Warranty: For special warranty.
- 1.05 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44 **[including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel]**.
 - B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
 - C. Continuing Maintenance Proposal:
 1. Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
- 1.06 QUALITY ASSURANCE
- A. Installer Qualifications: Elevator manufacturer **[or an authorized representative who is trained and approved by manufacturer]**.
- 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.08 COORDINATION

- A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.09 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: three (3) year from date of Substantial Completion.
 - 3. Response time for repairs shall be within 24 hours.
 - 4. Emergencies response time shall be less than 3 hours at no additional cost to the College.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain electric traction elevators [, including freight and hydraulic elevators specified in other Sections,] from single manufacturer.
 - 1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, to be manufactured by single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Seismic Performance: Elevator system to withstand the effects of earthquake motions determined according to **[ASCE/SEI 7] <Insert requirement>** and to comply with elevator seismic requirements in ASME A17.1/CSA B44.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified **[and the system will be fully operational after the seismic event].**"

2. Project Seismic Design Category: **[C] [D] [E] [F]**.
3. Elevator Component Importance Factor: **[1.5] [1.0]**.
4. Design earthquake spectral response acceleration short period (Sds) for Project is **<Insert value>**.
5. Provide earthquake equipment required by ASME A17.1/CSA B44.
6. Provide seismic switch required by ASCE/SEI 7.

2.03 ELECTRIC TRACTION ELEVATORS

- A. See specific College Facility Design Standards for acceptable elevator manufacturers and controllers.
- B. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components to be used, as included in standard elevator systems and as required for complete system.
- C. Existing elevators in buildings to be modernized shall be modernized without changing the type of conveyance. The amount of change to an existing system shall be determined by the college (Director of College Facilities), the design professional, and the selected elevator consultant (i.e. lift and control cables, cylinders, inside and outside control panels, doors, etc.).
- D. Elevators shall have an elevator machine control room for equipment. The rooms shall be temperature controlled to limit heat to conform to the manufacturers operating instructions.
- E. Elevators and installations shall be of a make and design that they are maintainable by a third party.
- F. Elevator shall be designed so that during a power outage, the elevator will automatically return to the ground floor and the doors will open.
- G. Finishes inside the cab and elevator doors shall be stainless steel or vandal resistant material. Final approval of cab and door finishes shall be approved in writing (signed off) by the college.
- H. Elevator cabs and electrical lighting fixtures installed with the elevator shall be LED lighting.
- I. Elevator controls shall be of a generic type that can be maintained and replaced by a third party.
- J. Failure to comply
- K. Elevator Description:
 1. Machine Type: **[Geared] [Gearless]** traction.
 2. Rated Load: **[3500 lb] [4000 lb] [4500 lb] [5000 lb]** <Insert value>.
 3. Freight Loading Class for Service Elevator(s): Class A.
 4. Rated Speed: **[350 fpm] [400 fpm] [450 fpm] [500 fpm] [700 fpm] [800 fpm] [1000 fpm] [1200 fpm] [1400 fpm]** <Insert value>.
 5. Operation System: **[Selective-collective automatic operation] [Group automatic operation] [Group automatic operation with demand-based dispatching] [Destination-based group automatic operation]**.
 6. Auxiliary Operations:

- a. Standby power operation.
 - b. Standby-powered lowering.
 - c. Battery-powered automatic evacuation.
 - d. Automatic dispatching of loaded car.
 - e. Nuisance-call cancel.
 - f. Loaded-car bypass.
 - g. Distributed parking.
 - h. Off-peak operation.
 - i. Automatic operation of lights and ventilation fans.
 - j. [Emergency hospital] [Priority] service at [all] <Insert floor designations> floors.
 - k. Independent service for [service elevator] [one car in group] [all cars in group].
7. Security Features: [Card-reader operation] [Keyswitch operation] [Keypad operation] [Car-to-lobby feature].
8. Dual Car-Control Stations: Provide two car-control stations [in each elevator]; equip only one with required keyswitches if any.
9. Car Enclosures:
- a. Inside Width: [Not less than] [64 inches] [66 inches] [68 inches] [70 inches] [80 inches] [89-1/2 inches] [92 inches] <Insert dimension> from side wall to side wall.
 - b. Inside Depth: [Not less than] [51 inches] [53 inches] [56-1/2 inches] [60 inches] [64-1/2 inches] [66 inches] [68 inches] [88 inches] [89 inches] [90-1/2 inches] [93-1/2 inches] [95 inches] [96-1/2 inches] [101 inches] [102 inches] [104 inches] [108 inches] <Insert dimension> from back wall to front wall (return panels).
 - c. Inside Height: Not less than [93 inches] <Insert dimension> to underside of ceiling.
 - d. Front Walls (Return Panels): [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - e. Car Fixtures: [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - f. Side and Rear Wall Panels: [Enameled or powder-coated steel] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Textured stainless steel] [Satin bronze, lacquered].
 - g. Reveals: [Black] [Enameled or powder-coated steel] [Anodized aluminum] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - h. Door Sills: [Aluminum] [Bronze] [Nickel silver].

- i. Ceiling: [Luminous ceiling] [Enameled or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Reflective metallic-finish, plastic-laminate, stainless steel] [Reflective metallic-finish, plastic-laminate, bronze].
 - j. Handrails: [**1-1/2 inches** round] [**1/2 by 2 inches** rectangular] <Insert dimension> [anodized aluminum] [mirror-polished stainless steel] [satin stainless steel] [mirror-polished bronze, lacquered] [satin bronze, lacquered], at [sides] [and] [rear] of car.
 - k. Floor: Manufacturer's standard carpet.
 - l. Floor prepared to receive carpet (specified in Section 09 68 16 "Sheet Carpeting").
 - m. Floor prepared to receive resilient flooring (specified in Section 09 65 16 "Resilient Sheet Flooring").
 - n. Floor recessed and prepared to receive [dimension stone tile (specified in Section 09 30 33 "Stone Tiling")] [ceramic tile (specified in Section 09 30 13 "Ceramic Tiling")].
 - o. Floor Thickness, Including Setting Materials: <Insert thickness> above plywood subfloor.
10. Hoistway Entrances:
- a. Width: [**36 inches**] [**42 inches**] [**48 inches**] [**54 inches**] <Insert dimension>.
 - b. Height: [**84 inches**] <Insert dimension>.
 - c. Type: [Single-speed side sliding] [Two-speed side sliding] [Single-speed center opening] [Two-speed center opening].
 - d. Frames: [At first floor.] [At basement floor.] [Enameled or powder-coated steel] [Primed or powder-coated steel] [Primed or powder-coated steel to receive stone] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered] [Steel subframes to receive stone].
 - e. Frames at Other Floors: [Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - f. Doors and Transoms: [At first floor.] [At basement floor.] [Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Textured stainless steel] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - g. Doors and Transoms at Other Floors: [Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Textured stainless steel] [Polished bronze, lacquered] [Satin bronze, lacquered].
 - h. Sills: [At first floor.] [At basement floor.] [Aluminum] [Bronze] [Nickel silver].
 - i. Sills at Other Floors: [**Aluminum**] [**Bronze**] [**Nickel silver**].
11. Hall Fixtures: [At first floor.] [At basement floor.] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered] [Recessed type with no exposed-metal surfaces].

12. Hall Fixtures at Other Floors: [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered] [Recessed type with no exposed-metal surfaces].
13. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from [polished stainless steel, ASTM A480/A480M, No. 8 finish] [satin stainless steel, ASTM A480/A480M, No. 4 finish] [polished bronze, lacquered] [satin bronze, lacquered].
 - b. Provide hooks for protective pads in **[service car] [all cars]** and **[one] [two]** <Insert number> complete set(s) of full-height protective pads.

2.04 TRACTION SYSTEMS

- A. Elevator Machines: Variable-voltage, variable-frequency, ac-type hoisting machines **[or variable-voltage dc-type hoisting machines]** and solid-state power converters.
 1. Provide [regenerative] [or] [nonregenerative] system.
 2. Provide regenerative system that complies with the IgCC.
 3. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
 4. Provide means for absorbing regenerated power when elevator system is operating on standby power.
 5. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.
- B. Fluid for Hydraulic Buffers: Fire-resistant fluid.
- C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 05 50 00 "Metal Fabrications" for materials and fabrication.
- E. Car Frame and Platform: Bolted- or welded-steel units.
- F. Guides: **[Roller guides] [or] [polymer-coated, nonlubricated sliding guides]**. Provide guides at top and bottom of car and counterweight frames.

2.05 OPERATION SYSTEMS

- A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.
- B. Group Automatic Operation with Demand-Based Dispatching: Provide **[reprogrammable]** group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger **[wait time] [time to destination]**. System automatically adjusts to demand changes for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

- C. Destination-Based Group Automatic Operation: Provide reprogrammable group automatic system that assigns elevators leaving the main lobby in the up direction to a selected group of floors and directs passengers to an elevator serving their destination floor. System dispatches cars in a regulated sequence for optimum system efficiency; dispatch is based on origin and destination of calls. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.
- D. Auxiliary Operations:
1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at **[main lobby] [fire-command station] <Insert location>**. Manual operation causes automatic operation to cease.
 2. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
 3. Single-Car Battery-Powered Automatic Evacuation: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it moves to the next floor above or below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
 4. Group Standby Power Operation:
 - a. On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at **[main lobby] [fire-command station] <Insert location>**. Manual operation causes automatic operation to cease.
 - b. On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at **[main lobby] [fire-command station] <Insert location>**.
 5. Group Battery-Powered Automatic Evacuation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are moved one at a time to the next floor above or below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
 6. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
 7. Nuisance-Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls **[and predetermined weight]** can be adjusted.
 8. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.

9. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone to include the main floor and adjacent floors; remaining floors to be divided into approximately equal zones.
10. Off-Peak Operation: During periods of low traffic, half of the elevators in a group to be taken out of service and switched to low power mode.
11. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
12. Priority Service: Service is initiated by a **[keyswitch] [card reader] [remote switch]** at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks **[and a lighted sign directs passengers to exit elevator]**. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.
13. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.

E. Security features are not to not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at **[car-control stations] [and] [hall push-button stations]** to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. **[Allow space for card reader in car] [Provide stripe-swipe card reader integral with each car-control station]**.
 - a. Security access system equipment is **[specified in Section 28 15 00 "Access Control Hardware Devices."]** **[not in the Contract.]**
2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at **[car-control stations] [and] [hall push-button stations]**. Key is removable **[only in deactivated] [in either]** position.
3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time after landing button is pressed.
 - a. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.
4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes **[car] [all cars in a group]** to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.06 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer sounds and doors begin to close at reduced kinetic energy.

2.07 CAR ENCLOSURES

- A. Provide [enameled or powder-coated steel car enclosures to receive removable] [steel-framed car enclosures with nonremovable] wall panels, with [removable] car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
 - 2. See "Allowances" Paragraph in "Summary" Article for items to be provided under the Elevator Car Allowance. Provide items not included in the Elevator Car Allowance as needed for finished car [**including materials and finishes specified below**].
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 - 1. Subfloor:
 - a. Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.
 - b. Exterior, C-C Plugged grade plywood, not less than 7/8-inch nominal thickness.
 - 2. Floor Finish:
 - a. Specified in Section <Insert Section number> "<Insert Section title>."
 - b. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from full range of industry colors.
 - 3. Enameled or Powder-Coated Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied 3-coats of enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 - 4. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
 - 5. Bronze Wall Panels: Flush, formed-metal construction; fabricated from bronze sheet.
 - 6. Fabricate car with recesses and cutouts for signal equipment.
 - 7. Fabricate car door frame integrally with front wall of car.
 - 8. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 - 9. Primed or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied, rust-resistant primer or powder-coating for field painting.
 - 10. Stainless Steel Doors: Flush, hollow-metal construction; fabricated [from stainless steel sheet] [or] [by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].

11. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
12. Unfinished-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
13. Sight Guards: Provide sight guards on car doors.
14. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
15. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
16. Ceiling: [Metal] [Metallic-finish, plastic-laminate] flush panels, with [incandescent downlights in the center of] [four low-voltage downlights in] each panel. [Align ceiling panel joints with joints between wall panels.]
17. Light Fixture Efficiency: Not less than 35 lumens/W.
18. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.08 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile to accommodate hoistway wall construction.
 1. Where gypsum board wall construction is indicated, frames to be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies to comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, based on testing at as close-to-neutral pressure as possible according to **[NFPA 252] [or] [UL 10B]**.
 1. Fire-Protection Rating: [1 hour] [1-1/2 hours] <Insert rating> [with 30-minute temperature rise of **450 deg F**].
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 1. Enameled or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 2. Primed or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
 3. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
 4. Stainless Steel Frames: Formed from stainless steel sheet.
 5. Bronze Frames: Formed from cold- or hot-rolled steel sheet, with enamel or powder-coat finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
 6. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both jambs of hoistway door frames.

7. Enameled or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
8. Primed or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
9. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated [from stainless steel sheet] [or] [by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
10. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
11. Unfinished-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
12. Sight Guards: Provide sight guards on doors matching door edges.
13. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
14. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.09 SIGNAL EQUIPMENT

- A. Provide [hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled] [signal equipment designed for destination-based system]. Provide [vandal-resistant] buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard [recessed] [or] [semirecessed] car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
 1. Mark buttons and switches for function. Use both tactile symbols and Braille.
 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

- E. Firefighters' Two-Way Telephone Communication Service: Provide **[flush-mounted cabinet]** **[telephone jack]** in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in **[Section 28 46 21.11 "Addressable Fire-Alarm Systems."]** **[Section 28 46 21.13 "Conventional Fire-Alarm Systems."]**
- F. Car Position Indicator: Provide **[illuminated,]**digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- G. Hall Push-Button Stations: **[Provide one hall push-button station at each landing]** **[Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group]** **[Provide hall push-button stations at each landing as indicated].**
1. Provide **[manufacturer's standard wall-mounted units]** **[units with flat faceplate for mounting with body of unit recessed in wall].**
 2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
 3. Equip units with **[buttons]** **[or]** **[touch screen]** for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.
 - a. Provide a means for passengers to indicate that they have disabilities so control system can allow extra room in assigned car.
 - b. Provide for connecting units that require destination registration to building security access system so a card reader can be used to register calls.
 4. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in **[Section 28 46 21.11 "Addressable Fire-Alarm Systems."]** **[Section 28 46 21.13 "Conventional Fire-Alarm Systems."]**
- H. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide **[one of]** the following:
1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
 2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
 3. Units mounted in both jambs of entrance frame **[for each elevator].**
 4. Units mounted in both car door jambs **[; may be used only for single elevators or for two-car groups].**
- I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
1. At manufacturer's option, audible signals may be placed on cars.
- J. Hall Position Indicators: Provide **[illuminated,]**digital-display-type position indicators, located above **[each]** hoistway entrance at ground floor. Provide units with flat faceplate and with body of unit recessed in wall.
1. Integrate ground-floor hall lanterns with hall position indicators.

- K. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. **[For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.]**
 - L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
 - M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.
 - N. <Insert requirements>.
- 2.10 FINISH MATERIALS
- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.
 - B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.
 - C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.
 - D. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.
 - 1. Product: Subject to compliance with requirements, provide "<Insert product name or designation>" by <Insert manufacturer's name>.
 - 2. Metal surface is [satin polished] [satin relieved] [titanium nitride colored] [oxide colored] [satin polished and titanium nitride colored] [satin relieved and titanium nitride colored] [satin polished and oxide colored] [satin relieved and oxide colored] [color coated and satin relieved] [color coated and bright relieved] after texturing.
 - E. Stainless Steel Bars: ASTM A276/A276M, Type 304.
 - F. Stainless Steel Tubing: ASTM A554, Grade MT 304.
 - G. Bronze Plate and Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal).
 - H. Bronze Extrusions: ASTM B455/B455M, Alloy UNS No. C38500 (architectural bronze).
 - I. Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).
 - J. Aluminum Extrusions: ASTM B221, Alloy 6063.
 - K. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or UNS No. C77600.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF ELECTRIC TRACTION ELEVATORS

- A. Comply with manufacturer's written instructions.
- B. When replacing or eliminating hydraulic cylinders, the disposal of all related fluids shall comply with all federal, state and local regulations and guidelines. When removing in- ground cylinders, the remaining cavity shall be properly backfilled with concrete or other material approved by the college (Director of College Facilities).
- C. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- D. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- E. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- F. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- G. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.
- H. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- I. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 - 2. Place hall lanterns either above or beside each hoistway entrance.
 - 3. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.03 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Upon completion of work and prior to acceptance by the college, the fire alarm and communication systems must be tested and proven to be operational.
- C. Operating Test: Load **[elevator] [each elevator] [one elevator of each type, capacity, speed, and travel distance]** to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- D. Advise College, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.04 PROTECTION

- A. Temporary Use: **[Limit temporary use for construction purposes to one elevator.]** Comply with the following requirements for **[each]** elevator used for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 - 2. Provide strippable protective film on entrance and car doors and frames.
 - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 - 5. Do not load elevators beyond their rated weight capacity.
 - 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 - 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.05 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include **<Insert number>** months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies to be manufacturer's authorized replacement parts and supplies.
 - 1. Perform maintenance during normal working hours.
 - 2. Perform emergency callback service during normal working hours with response time of **[two] <Insert number>** hours or less.

3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of **[two]** <Insert number> hours or less.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate **[, adjust, and maintain]** elevator(s).
- B. Check operation of **[each]** elevator with Owner's personnel present before date of Substantial Completion **[and again not more than one month before end of warranty period]**. Determine that operation systems and devices are functioning properly.

END OF SECTION

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SECTION 14 24 00
HYDRAULIC ELEVATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Hydraulic elevators.
- B. Related Requirements:
 - 1. Section 05 12 00 "Structural Steel Framing" for the following:
 - a. Divider beams.
 - b. Hoist beams.
 - c. Structural-steel shapes for subsills that are part of steel frame.
 - 2. Section 05 50 00 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams are required if a shaft contains more than one elevator.
 - c. Divider beams.
 - d. Hoist beams.
 - e. Structural-steel shapes for subsills.
 - f. Pit ladders.
 - g. Cants made from steel sheet in hoistways.

1.02 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.03 ACTION SUBMITTALS

- A. Product Data: Hydraulic elevators.
- B. Product Data Submittals: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
 - 2. Include large-scale layout of car-control station [**and standby-power operation control panel**].

3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.
- D. Samples for Initial Selection: For finishes involving color selection.
 - E. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes, 3-inch-square Samples of sheet materials and 4-inch lengths of running trim members.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - C. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service **[including standby-power generator]**, as indicated and specified, are adequate for elevator system being provided.
 - D. Sample Warranty: For special warranty.
- 1.05 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44 **[including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel]**.
 - B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
 - C. Continuing Maintenance Proposal:
 1. Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
 2. Submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.
- 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer [or an authorized representative who is trained and approved by manufacturer].

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.08 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.09 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: three (3) years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 HYDRAULIC ELEVATORS

- A. See specific College Facility Design Standards for acceptable elevator manufacturers and controllers.
- B. Source Limitations: Obtain elevators [, including freight and electric traction passenger elevators specified in other Sections,] from single manufacturer.
 - 1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, are manufactured by single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

- B. Existing elevators in buildings to be modernized shall be modernized without changing the type of conveyance. The amount of change to an existing system shall be determined by the college (Director of College Facilities), the design professional, and the selected elevator consultant (i.e. lift and control cables, cylinders, inside and outside control panels, doors, etc.).
- C. Elevators shall have an elevator machine control room for equipment. The rooms shall be temperature controlled to limit heat to conform to the manufacturers operating instructions.
- D. Elevators and installations shall be of a make and design that they are maintainable by a third party.
- E. Elevator shall be designed so that during a power outage, the elevator will automatically return to the ground floor and the doors will open.
- F. Finishes inside the cab and elevator doors shall be stainless steel or vandal resistant material. Final approval of cab and door finishes shall be approved in writing (signed off) by the college.
- G. Elevator cabs and electrical lighting fixtures installed with the elevator shall be LED lighting.
- H. Elevator controls shall be of a generic type that can be maintained and replaced by a third party.
- I. Accessibility Standard: Comply with applicable provisions in [the United States Access Board's ADA-ABA Accessibility Guidelines] [and] [ICC A117.1].
- J. Seismic Performance: Elevator system withstands the effects of earthquake motions determined according to **[ASCE/SEI 7]** <Insert requirement> and complies with elevator seismic requirements in ASME A17.1/CSA B44.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified [**and the system will be fully operational after the seismic event**]."
 - 2. Project Seismic Design Category: **[C] [D] [E] [F]**.
 - 3. Elevator Component Importance Factor: **[1.5] [1.0]**.
 - 4. Design earthquake spectral response acceleration short period (Sds) for Project is <Insert value>.
 - 5. Provide earthquake equipment required by ASME A17.1/CSA B44.
 - 6. Provide seismic switch required by ASCE/SEI 7.

2.03 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components are used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
 - 1. Group Number: <Insert a different number for each group of elevators that share a group operation system>.

2. Elevator Number(s): <Insert elevator number(s) as indicated on Drawings>.
3. Emergency Elevator Number(s): <Insert elevator number(s) as indicated on Drawings>.
4. Service Elevator Number(s): <Insert elevator number(s) as indicated on Drawings>.
5. Type:
 - a. Under-the-car single cylinder.
 - b. Holeless, beside-the-car, single-acting, **[single] [dual]** cylinder.
 - c. Holeless, beside-the-car, telescoping, **[single] [dual]** cylinder.
 - d. Holeless, beside-the-car, roped hydraulic, **[single] [dual]** cylinder.
6. Rated Load: **[3500 lb] [4000 lb] [4500 lb] [5000 lb]** <Insert value>.
7. Freight Loading Class for Service Elevators: Class A.
8. Rated Speed: **[125 fpm] [150 fpm] [175 fpm] [200 fpm]** <Insert value>.
9. Operation System: **[Single automatic operation] [Selective-collective automatic operation] [Group automatic operation]**.
10. Auxiliary Operations:
 - a. Standby-powered lowering.
 - b. Battery-powered lowering.
 - c. Nuisance call cancel.
 - d. Automatic operation in first subparagraph below is required by IgCC.
 - e. Automatic operation of lights and ventilation fans.
 - f. **[Emergency hospital] [Priority]** service at **[all]** <Insert floor designations> floors.
 - g. Always retain first subparagraph below if group includes a service elevator.
 - h. Independent service for **[service elevator] [one car in group] [all cars in group]**.
11. Security Features: **[Card-reader operation] [Keyswitch operation] [Keypad operation] [Car-to-lobby feature]**.
12. Dual Car-Control Stations: Provide two car-control stations **[in each elevator]**; equip only one with required keyswitches if any.
13. Car Enclosures:
 - a. If standard cars are unacceptable, detail cars on Drawings or use an allowance and retain only those subparagraphs below specifying car dimensions and describing items not included in allowance.
 - b. Before retaining options in "Inside Width" and "Inside Depth" subparagraphs below, verify that selected configuration complies with requirements for providing accessibility to people with disabilities and to emergency stretchers if required. Revise descriptions of width and depth if car has more than one entrance.
 - c. Inside Width: **[Not less than] [64 inches] [66 inches] [68 inches] [70 inches] [80 inches] [89-1/2 inches] [92 inches]** <Insert dimension> from side wall to side wall.
 - d. Inside Depth: **[Not less than] [51 inches] [53 inches] [56-1/2 inches] [60 inches] [64-1/2 inches] [66 inches] [68 inches] [88 inches] [89 inches] [90-1/2 inches] [93-1/2 inches] [95 inches] [96-1/2 inches] [101 inches] [102 inches] [104 inches] [108 inches]** <Insert dimension> from back wall to front wall (return panels).

- e. Inside Height: Not less than **[93 inches]** <Insert dimension> to underside of ceiling.
- f. Front Walls (Return Panels): **[Polished stainless steel, ASTM A480/A480M, No. 8 finish]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Polished bronze, lacquered]** **[Satin bronze, lacquered]** with integral car door frames.
- g. Delete "Car Fixtures" Subparagraph below if retaining "Swing-Return Car-Control Stations" Paragraph in "Signal Equipment" Article.
- h. Car Fixtures: **[Polished stainless steel, ASTM A480/A480M, No. 8 finish]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Polished bronze, lacquered]** **[Satin bronze, lacquered]**.
- i. Side and Rear Wall Panels: **[Enameled or powder-coated steel]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Textured stainless steel]** **[Satin bronze, lacquered]**.
- j. Reveals: **[Black]** **[Enameled or powder-coated steel]** **[Polished stainless steel, ASTM A480/A480M, No. 8 finish]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Polished bronze, lacquered]** **[Satin bronze, lacquered]**.
- k. Plastic-laminate doors are about as expensive as stainless steel doors but are not as durable.
- l. Door Faces (Interior): **[Enameled or powder-coated steel]** **[Primed or powder-coated steel]** **[Polished stainless steel, ASTM A480/A480M, No. 8 finish]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Textured stainless steel]** **[Polished bronze, lacquered]** **[Satin bronze, lacquered]**.
- m. Nickel silver and bronze door sills are more durable than aluminum door sills but are more expensive.
- n. Door Sills: **[Aluminum]** **[Bronze]** **[Nickel silver]**.
- o. Ceiling: **[Luminous ceiling]** **[Enameled or powder-coated steel]** **[Polished stainless steel, ASTM A480/A480M, No. 8 finish]** **[Satin stainless steel, ASTM A480/A480M, No. 4 finish]** **[Polished bronze, lacquered]** **[Reflective metallic-finished plastic laminate, resembling stainless steel]** **[Reflective metallic-finished plastic laminate, resembling bronze]**.
- p. Handrails: **[1-1/2 inches round]** **[1/2 by 2 inches rectangular]** <Insert dimension(s)> **[anodized aluminum]** **[mirror-polished stainless steel]** **[satin stainless steel]** **[mirror-polished bronze, lacquered]** **[satin bronze, lacquered]**, at **[sides]** **[and]** **[rear]** of car.
- q. Floor: Manufacturer's standard carpet.
- r. Floor prepared to receive carpet (specified in Section 09 68 16 "Sheet Carpeting").
- s. Floor prepared to receive resilient flooring (specified in Section 09 65 00 "Resilient Flooring").
- t. If retaining first subparagraph below, coordinate with tile-setting method. Both Sections referenced in options below contain provisions for floor tile installation over wood using water-cleanable, tile-setting epoxy or thinset mortar on cementitious backer units (included in tile Sections). ASME A17.1/CSA B44 requires that elevator floors and floor members be designed to limit deflection to L/960, which should be stiff enough to eliminate tile cracking.
- u. Floor recessed and prepared to receive **[dimension stone tile (specified in Section 09 30 33 "Stone Tiling")]** **[ceramic tile (specified in Section 09 30 13 "Ceramic Tiling")]**.

- v. Retain first subparagraph below for floors thicker than the typical 1/4 to 5/8 inch (6 to 16 mm) to let the manufacturer know how much to raise the car door sill and doors above the car subfloor.
 - w. Floor Thickness, Including Setting Materials: <Insert thickness> above plywood subfloor.
14. Hoistway Entrances:
- a. Width: **[36 inches] [42 inches] [48 inches] [54 inches]** <Insert dimension>.
 - b. Height: **[84 inches]** <Insert dimension>.
 - c. Type: **[Single-speed side sliding] [Two-speed side sliding] [Single-speed center opening] [Two-speed center opening]**.
 - d. If frames are same at all floors, delete first two options in first subparagraph below and delete second subparagraph below.
 - e. Frames: **[At first floor.] [At basement floors.] [Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered]**.
 - f. Frames at Other Floors: **[Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered]**.
 - g. Plastic-laminate doors are about as expensive as stainless steel doors but are not as durable. If doors are same at all floors, delete first two options in first subparagraph below and delete second subparagraph below.
 - h. Doors and Transoms: **[At first floor.] [At basement floors.] [Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Textured stainless steel] [Polished bronze, lacquered] [Satin bronze, lacquered]**.
 - i. Doors and Transoms at Other Floors: **[Enameled or powder-coated steel] [Primed or powder-coated steel] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Textured stainless steel] [Polished bronze, lacquered] [Satin bronze, lacquered]**.
 - j. Nickel silver and bronze sills are more durable than aluminum sills but are more expensive. If sills are same at all floors, delete first two options in first subparagraph below and delete second subparagraph below.
 - k. Sills: **[At first floor.] [At basement floors.] [Aluminum] [Bronze] [Nickel silver]**.
 - l. Sills at Other Floors: **[Aluminum] [Bronze] [Nickel silver]**.
15. Hall Fixtures: **[At first floor.] [At basement floors.] [Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered] [Recessed type with no exposed-metal surfaces]**.
16. Hall Fixtures at Other Floors: **[Polished stainless steel, ASTM A480/A480M, No. 8 finish] [Satin stainless steel, ASTM A480/A480M, No. 4 finish] [Polished bronze, lacquered] [Satin bronze, lacquered] [Recessed type with no exposed-metal surfaces]**.
17. Additional Requirements:

- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from [polished stainless steel, ASTM A480/A480M, No. 8 finish] [satin stainless steel, ASTM A480/A480M, No. 4 finish] [polished bronze, lacquered] [satin bronze, lacquered].
- b. Provide hooks for protective pads in [service car] [all cars] and [one] [two] <Insert number> complete set(s) of full-height protective pads.

2.04 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 1. Pump is [submersible type with submersible squirrel-cage induction motor, and suspended inside oil tank from vibration isolation mounts] [or] [is tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and is mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch-thick, glass-fiber insulation board].
 2. Motor has [wye-delta] [or] [solid-state] starting.
 3. Motor has variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System has hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
 1. Cylinder units are connected with dielectric couplings.
 2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D1785, joined with PVC fittings complying with ASTM D2466 and solvent cement complying with ASTM D2564.
- D. Hydraulic Fluid:
 1. Hydraulic Fluid, Manufacturer's Standard: Elevator manufacturer's standard [fire-resistant] fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
 2. Hydraulic Fluid, Nontoxic and Biodegradable: Nontoxic, biodegradable [, fire-resistant] fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment.
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than 1-inch clearance from cylinder and extending above pit floor. Casing has means of monitoring effectiveness to comply with ASME A17.1/CSA B44.
- G. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below 60 deg F.
- H. Car Frame and Platform: Welded [or bolted] steel units.

- I. Guides: **[Roller guides]** **[Polymer-coated, nonlubricated sliding guides]** **[or]** **[sliding guides with guide-rail lubricators]**. Provide guides at top and bottom of car frame.

2.05 OPERATION SYSTEMS

- A. Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

- B. Auxiliary Operations:

1. Single-Car Standby-Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at **[main lobby]** **[fire command station]** **<Insert location>**. Manual operation causes automatic operation to cease.
2. Single-Car Standby-Powered Lowering:
 - a. On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down.
 - b. On activation of standby power, car is lowered to the lowest floor, opens its doors, and shuts down.
3. Single-Car Battery-Powered Lowering:
 - a. If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
 - b. When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
4. Group Standby-Power Operation:
 - c. On activation of standby power, cars are returned to a designated floor and parked with doors open. Only one car is moved upward at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at **[main lobby]** **[fire command station]** **<Insert location>**. Manual operation causes automatic operation to cease.
 - d. On activation of standby power, cars are returned to lowest floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch located at **[main lobby]** **[fire command station]** **<Insert location>**.
5. Group Standby-Powered Lowering:
 - e. On activation of standby power, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down.

- f. On activation of standby power, cars are lowered to the lowest floor, open their doors, and shut down.
 6. Group Battery-Powered Lowering:
 - g. If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
 - h. When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
 7. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.
 8. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls [**and predetermined weight**] can be adjusted.
 9. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
 10. Off-Peak Operation: During periods of low traffic, half of the elevators in a group are taken out of service and switched to low-power mode.
 11. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
 12. Priority Service: Service is initiated by a [**keyswitch**] [**card reader**] [**remote switch**] at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks [, **and a lighted sign directs passengers to exit elevator**]. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car returns to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.
 13. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.
- C. Security Features: Security features do not affect emergency firefighters' service.
1. Card-Reader Operation: System uses card readers at [**car-control stations**] [**and**] [**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space for card reader in car**] [**Provide stripe-swipe card reader integral with each car-control station**].
 - i. Security access system equipment is [specified in Section 28 15 00 "Access Control Hardware Devices."] [not in the Contract.]
 2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**] [**and**] [**hall push-button stations**]. Key is removable [**only in deactivated position**] [**in either position**].

3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.
 - j. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.
4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes **[car]** **[all cars in a group]** to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.06 DOOR-REOPENING DEVICES

- A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer sounds and doors begin to close at reduced kinetic energy.

2.07 CAR ENCLOSURES

- A. Provide **[enameled- or powder-coated-steel car enclosures to receive removable]** **[steel-framed car enclosures with nonremovable]** wall panels, with **[removable]**car roof, access doors, power door operators, and ventilation.
 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
 2. See "Allowances" Article for items to be provided under the Elevator Car Allowance. Provide items not included in the Elevator Car Allowance as needed for finished car **[, including materials and finishes specified below]**.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 1. Subfloor:
 - a. Retain one of first two subparagraphs below. First is typical subfloor for carpet or resilient flooring; second provides a stiffer subfloor for ceramic tile or dimension stone.
 - b. Exterior, underlayment-grade plywood, not less than 5/8-inch nominal thickness.
 - c. Exterior, C-C Plugged grade plywood, not less than 7/8-inch nominal thickness.
 2. Floor Finish:
 - a. Retain one of first two subparagraphs below.
 - b. Specified in <Insert Section number> "<Insert Section title>."
 - c. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from manufacturer's full range.
 3. Enameled- or Powder-Coated-Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.

4. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
5. Bronze Wall Panels: Flush, formed-metal construction; fabricated from bronze sheet.
6. Fabricate car with recesses and cutouts for signal equipment.
7. Fabricate car door frame integrally with front wall of car.
8. Enameled- or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
9. Primed or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder coating for field painting.
10. Stainless Steel Doors: Flush, hollow-metal construction; fabricated [from stainless steel sheet] [or] [by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
11. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
12. Unfinished-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder coating.
13. Sight Guards: Provide sight guards on car doors.
14. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
15. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
16. Ceiling: [Metal] [Metallic-finish, plastic-laminate] flush panels, with [incandescent downlights in the center of] [four low-voltage downlights in] each panel. [Align ceiling panel joints with joints between wall panels.]
17. Light Fixture Efficiency: Not less than 35 lumens/W.
18. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.08 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile accommodate hoistway wall construction.
 1. Where gypsum board wall construction is indicated, frames are self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to [NFPA 252] [or] [UL 10B].
 1. Fire-Protection Rating: [1 hour] [1-1/2 hours] <Insert rating> [with 30-minute temperature rise of 450 deg F].
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled- or Powder-Coated-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
2. Primed or Powder-Coated-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, rust-resistant primer or coating for field painting. Provide with factory-applied 3-coats of enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range
3. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
4. Stainless Steel Frames: Formed from stainless steel sheet.
5. Bronze Frames: Formed from cold- or hot-rolled steel sheet, with enamel or powder-coat finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
6. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both jambs of hoistway door frames.
7. Enameled- or Powder-Coated-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
8. Primed or Powder-Coated-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
9. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated **[from stainless steel sheet] [or] [by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning]**.
10. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
11. Unfinished-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
12. Sight Guards: Provide sight guards on doors matching door edges.
13. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
14. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.09 SIGNAL EQUIPMENT

- A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide **[vandal-resistant]** buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard **[recessed] [or] [semirecessed]** car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.

2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
1. Mark buttons and switches for function. Use both tactile symbols and Braille.
 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- E. Firefighters' Two-Way Telephone Communication Service: Provide **[flush-mounted cabinet] [telephone jack]** in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in **[Section 28 46 21.11 "Addressable Fire-Alarm Systems."]** **[Section 28 46 21.13 "Conventional Fire-Alarm Systems."]**
- F. Car Position Indicator: Provide **[illuminated,]**digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- G. Hall Push-Button Stations: **[Provide one hall push-button station at each landing]** **[Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group]** **[Provide hall push-button station at each landing as indicated]**.
1. Provide **[manufacturer's standard wall-mounted units]** **[units with flat faceplate for mounting with body of unit recessed in wall]** **[jamb-mounted units]**.
 2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
 3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in **[Section 28 46 21.11 "Addressable Fire-Alarm Systems."]** **[Section 28 46 21.13 "Conventional Fire-Alarm Systems."]**
- H. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide **[one of]** the following:
1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
 2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
 3. Units mounted in both jambs of entrance frame **[for each elevator]**.
 4. Units mounted in both car door jambs **[; may be used only for single elevators or for two-car groups]**.
- I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.
- J. Hall Position Indicators: Provide **[illuminated,]**digital-display-type position indicators, located above **[each]** hoistway entrance at ground floor.
1. Provide units **[with flat faceplate for mounting and with body of unit recessed in wall]** **[integral with entrance head jamb]**.
 2. Integrate ground-floor hall lanterns with hall position indicators.
- K. Standby-Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. **[For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.]**
- L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby-power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
- M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.
- N. <Insert requirements>.
- 2.10 FINISH MATERIALS
- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.
- D. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304, with embossed texture rolled into exposed surface.
1. Product: Subject to compliance with requirements, provide "<Insert product name>" by **<Insert manufacturer's name>**.
 2. Metal surface is **[satin polished]** **[satin relieved]** **[titanium nitride colored]** **[oxide colored]** **[satin polished and titanium nitride colored]** **[satin relieved and titanium nitride colored]** **[satin polished and oxide colored]** **[satin relieved and oxide colored]** **[color coated and satin relieved]** **[color coated and bright relieved]** after texturing.
- E. Stainless Steel Bars: ASTM A276/A276M, Type 304.
- F. Stainless Steel Tubing: ASTM A554, Grade MT 304.
- G. Bronze Plate and Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal).
- H. Bronze Extrusions: ASTM B455/B455M, Alloy UNS No. C38500 (architectural bronze).

- I. Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).
- J. Aluminum Extrusions: ASTM B221, Alloy 6063.
- K. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or No. C77600.

PART 3 EXECUTION

2.11 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.12 INSTALLATION OF HYDRAULIC ELEVATORS

- A. Excavation for Cylinder: Drill well hole in [**each**] elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 31 20 00 "Earth Moving."
- B. Provide [**waterproof**] well casing [**as necessary**] to retain well-hole walls.
- C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole [**and provide permanent waterproof seal at bottom of well casing**].
 - 1. Fill void space between protective casing and cylinder with corrosion-protective filler.
 - 2. Align cylinder and fill space around protective casing with fine sand.
- D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between [**well**] [**protective**] casing and pit floor with 4 inches of nonshrink, nonmetallic grout.
- E. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- F. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- G. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- H. Install piping above the floor, where possible. Install underground piping in casing.

1. Excavate for piping and backfill encased piping according to applicable requirements in Section 31 20 00 "Earth Moving."
 - I. Lubricate operating parts of systems as recommended by manufacturers.
 - J. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
 - K. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.
 - L. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
 - M. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 2. Place hall lanterns either above or beside each hoistway entrance.
 3. Mount hall lanterns at a minimum of 72 inches above finished floor.
- 2.13 FIELD QUALITY CONTROL
- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
 - B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.
- 2.14 PROTECTION
- A. Temporary Use: **[Limit temporary use for construction purposes to one elevator.]** Comply with the following requirements for **[each]** elevator used for construction purposes:
 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 2. Provide strippable protective film on entrance and car doors and frames.
 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 5. Do not load elevators beyond their rated weight capacity.
 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

2.15 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate **[, adjust, and maintain]** elevator(s).
- B. Check operation of **[each]** elevator with Owner's personnel present before date of Substantial Completion **[and again not more than one month before end of warranty period]**. Determine that operation systems and devices are functioning properly.

2.16 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service includes **<Insert number>** months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies are manufacturer's authorized replacement parts and supplies.
 1. Perform maintenance during normal working hours.
 2. Perform emergency callback service during normal working hours with response time of **[two] <Insert number>** hours or less.
 3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of **[two] <Insert number>** hours or less.
- B. **<Insert elevator maintenance agreement>**.

END OF SECTION

SECTION 14 42 00

WHEELCHAIR LIFT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Wheelchair lift.
 - 2. Supplementary parts and components such as inserts, clips, fasteners, anchors, bracing, and other miscellaneous supports and accessories required for a complete installation.
 - 3. Inclined stairway chairlifts are not to be used at LACCD projects
- B. Related work:
 - 1. Division 16 for electrical power to lift motor.

1.02 SUBMITTALS

- A. Data: Manufacturer's data sheets, including equipment characteristics, and sequence of operations.
- B. Diagrams: Wiring diagram with connected loads.
- C. Shop drawings: Shop drawings: Identify travel, gates and all materials. Detail fabrication and assembly, weight, inserts, finishes, clearances, attachments, and other pertinent data.
- D. Closeout: With closeout submittals, provide the Owner a bound manual for the equipment. Include the following:
 - 1. Minimum of 5 keys.
 - 2. Include operating and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information.
 - 3. Special tools required to operate and/or adjust the lift.
 - 4. Straight line wiring diagram of as-installed circuits with index of location and function of all components.
 - 5. List name, address and telephone number of local (within a 50-mile radius of Project site) qualified service representative.
 - 6. Parts listing with sources indicated, recommended parts inventory listing.
 - 7. Emergency operating instructions, lubricating instructions, including recommended lubricant grade, and step-by-step adjusting procedures as used by the manufacturer/installer's field adjustor.

1.03 QUALITY ASSURANCE

- A. Installer's qualifications: Firm approved by the lift manufacturer and who has completed installations similar in material, design, and extent to that indicated for Project which have resulted in installations with a record of successful in-service performance.

- A. Regulatory requirements:
 - 1. In addition to local governing regulations, equipment shall comply with ASME/ANSI A17.1, "Safety Code for Elevators and Escalators" Parts XX and XXI.
 - 2. Elevator Code, CCR, Title 8, Section 3142.1, which provides safety regulations for lifts. This section incorporates ASME A18.1-2003, sections 2 and 5 by reference, and requires compliance with CCR, Title 8, Sections 3094.2(d), 3094.2(e), 2094.2(g), and 3094.2(p)..
- B. Manufacturer's inspections:
 - 1. Request the manufacturer's presence before start of this work to examine design and structural requirements, and as required thereafter to review installation procedures and completed work.
 - 2. Unsatisfactory conditions disclosed by the manufacturer's visits to the site shall be promptly and satisfactorily repaired and the areas reinspected by the manufacturer before work starts or resumes in affected areas.
- C. Pre-installation meeting:
 - 1. Prior to start of installation, arrange a pre-installation meeting between the manufacturer of the lift and the trade responsible for the installation.
 - 2. If more than one trade will be responsible for the work of this Section, these trades shall attend the meeting.
- D. Signage: Sign complying with visual sign requirements of ADA and CBC is required as follows:
 - 1. Lift capacity, and
 - 2. "No Freight" prohibiting the transport of materials or equipment Sign to be posted in a conspicuous place at each landing and within the platform enclosure and include the International Symbol of Accessibility.

1.04 HANDLING

- A. Procedure: In accordance with Division One.

PART 2 PRODUCTS

2.01 MANUFACTURER / MODEL

- A. Basis of design is wheelchair lift model < Insert Model > by The National Wheel-O-Vator Co., Inc., or equal by Cheney Wheelchair Lift, Inclinator Co. of America and Access Industries.
 - 1. Mitsubishi, Garaventa, Thyssen Krupp, TL Shield, or Equal.

2.02 DESCRIPTION

- A. Capacity:
 - 1. 500 lb.
 - 2. Static load rating of 2,500 lb.
 - 3. Safety factor of 5:1.
- B. Lift height: As indicated.

- C. Number of stops: As indicated.
- D. Motor: UL listed, 1/3 HP, 1750 rpm, single-phase, 115 AC, and 60 HZ, instant reversing.
- E. Drive: ACME Screw and ACME nut. ACME screw stops shall have a positive action with less than 1/4-inch of coasting once control button is released.
- F. Platform: Solid slip-resistant steel, 36 inches by 48 inches
- G. Vertical lift shall have a mini-pit for flush transition.
- H. Control switches: 24 V, constant pressure, key-operated switch mounted on the platform and at the top and bottom landings.
- I. Safety device: Provide a safety feature to lock the platform securely in place when the lift mechanism fails.
- J. Manual operation: Provide a device to operate the lift when the power to the unit fails or the unit stops for any reason.
- K. Guard rails: Solid metal, 42 inches high.
- L. Safety gate:
 - 1. Provide the manufacturer's standard gate, with all required hardware and appropriate interlocks to prevent opening of the gate unless the lift is at the stage level.
 - 2. Gate shall be of substantial construction with expanded metal lath in a welded tubular frame.
- M. Finish: Clean steel parts of foreign matters and rust to bright metal, then degrease and prime with a rust-inhibitive primer followed by 2 coats of enamel of the color selected by the Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine adjacent construction and supports.
- B. Correct conditions detrimental to the proper and timely execution of this work before proceeding with installation.

3.02 INSTALLATION

- A. Install the lift in compliance with ICC/A117.1, NEC and ASME A18.1 Guidelines, its manufacturer's instructions with minimum clearances to adjacent construction, and the following:
 - 1. Provide anchorage devices and fasteners where necessary for securing lift components to in-place construction; include threaded fasteners for concrete and masonry inserts, through-bolts, and other connectors as required.
 - 2. Perform cutting, drilling, and fitting required for installation of lift.
 - a. Set lift components accurately in location, alignment, and elevation, with edges and surfaces level, plumb, true, and free of rack as measured from established lines and levels.

3. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations.
 4. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- B. Final connections to the electrical system will be done as a part of Division 16.

3.03 FIELD QUALITY CONTROL

- A. Test lift for proper operation and adjust as required.
- B. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material used for shop painting. Apply to provide a smooth, minimum dry film thickness of 2 mils invisible after touchup from undamaged factory-finished surfaces.
- C. Clean exposed surfaces.

3.04 INSTRUCTIONS

- A. Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- D. Review data in maintenance manuals.
- E. Review data in maintenance manuals.
- F. Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

DIVISION 21

FIRE SUPPRESSION

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SECTION 21 13 00

FIRE PROTECTION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- F. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- H. FM - FM Global Approval Guide.
- I. NFPA -National Fire Protection Association.
- J. UL - Underwriter's Laboratory Fire Protection Equipment Directory.
- K. NFPA 13 – Standard for the Installation of Sprinkler Systems.
- L. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Materials and equipment provided under this Section to make a complete installation shall be UL Listed and/or FM Approved and in compliance with NFPA Standards.
- B. Products proposed as “or equal” shall be provided for review by the district with all of the necessary information required to make such a determination. Clarifications of proposed “or equal” products shall be submitted along with an itemized cost analysis for consideration by the district.

2.02 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

- A. General
 - 1. Piping shall meet applicable ANSI or ASTM standards requirements and shall have the manufacturer's name and standard marked on each length. Joints shall meet applicable ANSI and ASTM standards requirements.
- B. Piping – Above Ground 2” and Under:
 - 1. Design Pressure: 175 psig

2. Pipe: Schedule 40, black steel, ANSI/ASTM A53, ASTM A795, UL/FM. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating. Exposed pipe to weather shall be galvanized.
 3. Joints: Threaded.
 4. Fittings:
 - a. Threaded:
 - 1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.4.
 - 2) Malleable iron, Class 150, black, UL/FM, ANSI/ASME B16.3.
 - 3) Steel, Class 150, black, UL/FM, ASME B16.11.
- C. Piping – Above Ground 2-1/2” and Above:
1. Design Pressure: 175 psig
 2. Pipe: Schedule 10, black steel, ASTM A135, ASTM A795, UL/FM. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating. Exposed pipe to weather shall be galvanized.
 - a. Joints: Roll grooved or flanged.
 - b. Fittings:
 - 1) Grooved:
 - a) Ductile iron housing ASTM A-536, Grade 65-45-12, UL/FM, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts. Acceptable Manufacturers: Victaulic, Gruvlok or Central.
 - 2) Flanged:
 - a) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.1.
- D. Standpipe System
1. Piping 2 1/2” and larger may be Schedule 10 black steel conforming to ASTM 135. Exposed pipe to weather shall be galvanized.
 2. Piping 2” and smaller shall be Schedule 40 black steel conforming to ASTM A53. Exposed pipe to weather shall be galvanized.
- 2.03 VALVES
- A. General Requirements:
1. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
- B. Ball Valves:
1. Valves 1-1/2” and Smaller: Bronze body with threaded ends.
 2. Valves 2” and 2-1/2”: Bronze body with threaded ends or ductile-iron body with grooved ends.
 3. Valves 3”: Ductile-iron body with grooved ends.

C. Check Valves:

1. 2 inches and smaller, 200 psi WOG, swing type, Bronze body, bronze disc, conforming to MSS-SP-80-97, threaded ends. Acceptable Manufacturers: Crane, Nibco, or Stockham or Equal as determined by LACCD.
2. 2-1/2" inches or larger, 250 psig, Swing check Cast iron body, grooved or flanged ends. Acceptable Manufacturers: Stockham, Kennedy, or Tyco or Equal as determined by LACCD.

D. Bronze OS&Y Gate Valves:

1. 2 inches and smaller, class 175, bronze body, solid bronze wedge disc, OS&Y, copper silicon alloy stem, UL/FM listed, threaded ends. Acceptable Manufacturers: Stockham, Crane, or Nibco or Equal as determined by LACCD.

E. Iron OS&Y Gate Valves:

1. 2 1/2-inch and larger, class 175, Cast or ductile iron body, solid wedge disc, OS&Y, Teflon-impregnated packing, UL/FM listed, flanged or grooved ends. Acceptable Manufacturers: Stockham, Crane, Kennedy, Mueller or Equal as determined by LACCD.

F. Indicating-Type Butterfly Valves:

1. 300 psi, UL/FM listed, with weatherproof gearbox and double pole/double throw monitor switch, double seal design for bubble tight shut off at 175 psi, grooved or flanged ends. Acceptable Manufacturers: Kennedy, Nibco, Victaulic or Tyco or Equal as determined by LACCD.
2. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch visual indicating device.

2.04 TRIM AND DRAIN VALVES

A. General Requirements:

1. Pressure Rating: 175 psig minimum.

B. Provide Angle Valves, Ball Valves, Globe Valves, Plug Valves

2.05 SPECIALTY VALVES

A. General Requirements:

1. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig minimum.
2. Body Material: Cast or ductile iron, Size: Same as connected piping, End Connections: Flanged or grooved.

B. Alarm Valves:

1. Design: For horizontal or vertical installation, include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer, Drip Cup Assembly: Pipe drain with check valve to main drain piping. Acceptable Manufacturers: Victaulic, Viking or Reliable or Equal as determined by LACCD..

C. Post Indicator Valves:

1. 4" and larger, ductile iron, fusion bonded epoxy coated resilient wedge, class 175 lb, non-rising stem, mounting plate for indicator post, UL/FM listed, flanged or mechanical ends (in accordance with NSF 61). Acceptable Manufacturers: Stockham, Kennedy, Clow, Mueller or Victaulic or Equal as determined by LACCD.

2.06 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Type: Exposed, projecting, for wall mounting.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Corrosion-resistant metal.
4. Inlets: Brass with threads according to local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
5. Caps: Brass, lugged type, with gasket and chain.
6. Escutcheon Plate: Round, brass, wall type.
7. Escutcheon Plate Marking: Similar to "[AUTO SPKR & STANDPIPE] or [AUTO SPKR]."
8. Outlet: Back, with pipe threads.
9. Number of Inlets: [Two] [Three] [Four] [Six].
10. UL/FM listed.
11. Finish: [Polished chrome plated] [Rough brass or bronze] [Rough chrome plated].
12. Outlet Size: [4"] [5"] [6"].
13. Acceptable Manufacturers: Potter Roemer, Tyco or Powhatten or equal as approved by the District.

B. Flush-Type, Fire-Department Connection:

1. Type: Flush, for wall mounting.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Corrosion-resistant metal.
4. Inlets: Brass with threads according to local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

5. Caps: Brass, lugged type, with gasket and chain.
 6. Escutcheon Plate: Rectangular, brass, wall type.
 7. Escutcheon Plate Marking: Similar to “ [AUTO SPKR & STANDPIPE] [AUTO SPKR].”
 8. Outlet: Back with pipe threads.
 9. Body Style: [Horizontal] [Square] [Vertical].
 10. Number of Inlets: [Two] [Three] [Four] [Six].
 11. Outlet Location: [Back] [Bottom] [Left side] [Right side] [Top].
 12. Finish: [Polished chrome plated] [Rough brass or bronze] [Rough chrome plated].
 13. Outlet Size: [4”] [5”] [6”] [8”].
 14. Acceptable Manufacturers: Potter Roemer, Tyco or Powhatan.
- C. Yard-Type, Fire-Department Connection:
1. Type: Exposed, freestanding.
 2. Pressure Rating: 175 psig minimum.
 3. Body Material: Corrosion-resistant metal.
 4. Inlets: Brass with threads according to local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 5. Caps: Brass, lugged type, with gasket and chain.
 6. Escutcheon Plate: Round, brass, floor type.
 7. Escutcheon Plate Marking: Similar to “ [AUTO SPKR & STANDPIPE] [AUTO SPKR].”
 8. Outlet: Bottom, with pipe threads.
 9. Number of Inlets: [Two] [Three] [Four] [Six]..
 10. Sleeve: [Brass] [Not required].
 11. Sleeve Height: 18 inches.
 12. Finish [Including Sleeve]: [Polished chrome plated] [Rough brass or bronze] [Rough chrome plated].
 13. Outlet Size: [4”] [5”] [6”].
 14. Acceptable Manufacturers: Potter Roemer, Tyco or Powhatan.

2.07 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flow Detection and Test Assemblies:

1. Pressure Rating: 175 psig minimum, Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve, Size: Same as connected piping.
2. Inlet and Outlet: Threaded.
3. Acceptable Manufacturers: AGF Manufacturing.

B. Seismic Swing Joints:

1. UL/FM Approved flexible seismic connector or fittings with grooved, or threaded ends for seismic separation requirements. Acceptable Manufacturers: Metraflex, Victaulic.

2.08 SPRINKLERS

A. General Requirements:

1. Pressure Rating for Automatic Sprinklers: 175 psig minimum, Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum, Sprinklers with O-rings are not permitted. Acceptable Manufacturers: Victaulic, Tyco, Viking or Reliable or equal as determined by the District.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: Characteristics: Nominal ½-inch orifice with Discharge Coefficient K of 5.6, and 8.0 for "Ordinary" temperature classification rating unless otherwise indicated by this specification or required by application, Provide ½ inch thread for K5.6 and ¾ inch thread for K8.0. Acceptable Manufacturers: Victaulic, Tyco, Viking or Reliable or equal as determined by the District.

C. Sprinkler Finishes:

1. Chrome plated. To be provided in spaces with finished ceilings, drop ceilings or public spaces with exposed ceilings
2. Bronze. To be provided in back of house spaces with exposed ceilings
3. Painted. To be provided in spaces with finished ceilings as determined by project architect.

D. Special Coatings:

1. Dry-Type to be used in areas subject to freezing
2. Corrosion resistant coating in corrosive environments only

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: [Chrome-plated steel, one piece, flat] [Chrome-plated steel, two piece, with 1-inch vertical adjustment].
2. Sidewall Mounting: [Chrome-plated steel] , one piece, flat.

3. Acceptable Manufacturers: FPPI, Tyco or Reliable or equal as determined by the District.

F. Sprinkler Guards:

1. Guards shall be UL/FM listed, supplied and approved for use with the sprinkler by the sprinkler manufacturer. Sprinkler head guards shall securely fasten with bolt-on feature to the base of the sprinkler or be a factory installed guard. Approved Manufacturers: Reliable, Viking, Tyco or Victaulic.

G. Flexible piping systems shall be UL Listed and FM Approved and suitable for their intended use. All flexible piping connections shall include a fully welded, braided, leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1"; and a one-piece multi-port ceiling bracket with removable attachments hub and self-securing integrated snap-on clip ends for attachment to the ceiling grid without the need for a screw fastener. Acceptable Manufacturers: Flexhead Industries, Victaulic VicFlex, or Sprinkflex or equal as determined by the District.

2.09 ALARM DEVICES

A. Water-Flow Indicators:

1. UL/FM Listed, electrically supervised, Components: Two double-throw circuit switches for isolated alarm and auxiliary contacts, complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed, Type: Paddle operated with screw terminals, Pressure Rating: 250 psig, Design Installation: Horizontal or vertical, Time Delay Feature: from 0 to [30] [45] seconds. Acceptable Manufacturers: Potter Roemer or Notifier.

B. Valve Supervisory Switches:

1. UL/FM Listed, electrically supervised with screw terminals, Components: Double- pole, double-throw switch with normally closed contacts, Design: Signals that control valve is in other than fully open position. Acceptable Manufacturers: Potter Roemer or Notifier.

C. Indicator-Post Supervisory Switches:

1. UL/FM Listed, electrically supervised with screw terminals, Components: Double- throw switch with normally closed contacts, Design: Signals that controlled indicator-post valve is in other than fully open position. Acceptable Manufacturers: Potter Roemer or Notifier.

2.10 PRESSURE GAGES

A. Liquid filled, Dial Size: 4-1/2-inch diameter, Pressure Gage Range: 0 to 250 psig minimum, Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.11 PIPE ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One-Piece, Cast-Brass Escutcheons: [Polished chrome-plated] [or] [rough-brass] finish with set-screws.

C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome- plated finish.

D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with [set-screw] [or] [spring clips].

- E. Split-Casting, Cast-Brass Escutcheons: [Polished chrome-plated] [or] [rough-brass] finish with concealed hinge and set-screw.
- F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with [concealed] [exposed- rivet] hinge, [set-screw] [or] [spring clips].
- G. One-Piece Floor Plates: Cast-iron flange [with holes for fasteners].
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 SLEEVES

- A. Steel-Pipe Sleeves: ASTM A53/A53M, Type E, standard weight, plain ends.

2.13 HANGERS

- A. Materials available by product type. Provide materials to comply with location and application requirements unless noted otherwise on drawings and schedules.
 - 1. Pipe rings - Malleable iron, carbon steel.
 - 2. Clevis - Carbon steel.
 - 3. Steel pipe clamps - Carbon steel, alloy, stainless steel.
 - 4. Socket clamps - Carbon steel.
 - 5. Beam clamps - Malleable/ductile iron, hardened steel, carbon steel, forged steel.
 - 6. Structural attachments - Carbon steel, malleable iron.
 - 7. Ceiling plates/ceiling flanges - Plastic, cast iron, malleable iron.
 - 8. Concrete inserts and attachments – Malleable iron, carbon steel; stainless steel body, fiberglass bars, polypropylene disc (iron cross design).
 - 9. Rod attachments - Carbon steel, malleable iron, forged steel.
 - 10. Pipe supports - Carbon steel, cast iron.
 - 11. Pipe shields and saddles - Carbon steel, alloy steel, stainless steel.
 - 12. Pipe rolls - Cast iron, carbon steel.
 - 13. Guides - Carbon steel; slides, carbon steel with PTFE slide plates.
 - 14. Engineered hangers - Carbon steel, stainless steel, chrome molybdenum steel.
 - 15. Powder driven studs – Not permitted
- B. Finishes: Provide finishes to comply with location and application requirements unless noted otherwise on drawings and schedules.
 - 1. Electro-plating galvanizing process per ASTM B633.
 - 2. Hot Dipped galvanizing process per ASTM A153.

3. Epoxy paint.
4. Zinc-rich paint.
5. Copper
6. Standard primer shall meet Fed Spec TT-P-636.

2.14 SIGNAGE

- A. Provide [plastic], [steel] or [aluminum] signs for each valve and to identify hydraulic design. Signs shall have white lettering on a red background with holes for easy attachment. Enter pertinent data for each system on the hydraulic placard.

2.15 SPRINKLER CABINET

- A. Provide metal cabinet(s) as required containing a stock of spare sprinkler heads of all types and ratings installed as well as any special tools required for removal or replacement of the heads. The number of spare sprinklers shall conform to NFPA 13. The cabinet shall be located, in an area where the temperature will not exceed 100 degrees F (38 degrees C) and approved by the DSA Regional Fire Protection Engineer. Acceptable Manufacturer: Potter Roemer or Guardian.

END OF SECTION

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SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.03 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, riser diagrams and attachment details and all applicable documentation required by NFPA 13 for working drawings.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from design engineer, sub-contractors and installers of the items involved:
1. Domestic water piping.
 2. Compressed air piping.
 3. HVAC hydronic piping.
 4. Structural Members.
 5. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer, NICET Level IV Designer and professional engineer.
- C. Design Data:
1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Field Test Reports:
1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 2. Fire-hydrant flow test report.
- F. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.
- 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.09 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify Architect and Owner/District no fewer than three days in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without Architect's and Owner's written permission.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13.
 - 2. California DSA.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
 - 1. Available fire-hydrant flow test records indicate the following conditions:
 - a. Date: 6/30/2021.
 - b. Time: 8:30 a.m

- c. Performed by:.
 - d. Static Pressure at Residual Fire Hydrant XXXX: psig.
 - e. Measured Flow at Flow Fire Hydrant Y: gpm.
 - f. Residual Pressure at Residual Fire Hydrant X: psig.
2. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Building Service Areas: Ordinary Hazard, Group 1
 - 2) Electrical Equipment Rooms: Ordinary Hazard, Group 1
 - 3) General Storage Areas: Ordinary Hazard, Group 1
 - 4) Mechanical Equipment Rooms: Ordinary Hazard, Group 1
 - 5) Office and Public Areas: Light Hazard
 - 6) Libraries and Classrooms: Light Hazard
 - 7) Laboratories and Vocational Spaces: Ordinary Hazard, Group 2
 - 8) High Piled Storage Locations: As Determined by CFC and NFPA 13
 - 9) Hazardous Materials and Flammable Liquids Storage Areas: Ordinary Hazard Group 2
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.2 gpm over 2000 sq ft or as specified in NFPA 13 based on specific hazard
 4. Maximum Protection Area per Sprinkler: According to UL listing.
 5. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft. (20.9 sq. m)
 - b. Storage Areas: 130 sq. ft. (12.1 sq. m)
 - c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m)
 - d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m)
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and California DSA.

2.02 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B . Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Malleable- or Ductile-Iron Unions: UL 860.
- E. Cast-Iron Flanges: ASME 16.1, Class 125.
- F. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products USA Inc.
 - e. Smith-Cooper International.
 - f. Tyco Fire Products LP.
 - g. Victaulic Company.
 - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
 - 3. Galvanized, Painted, and Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.
- C. Body Material: Cast or ductile iron.

- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.

2.04 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products USA Inc.
 - d. Tyco Fire Products LP.
 - e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175-psig (1200-kPa)
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aegis Technologies, Inc.
 - b. CECA, LLC.
 - c. Corcoran Piping System Co.
 - d. Merit Manufacturing.
 - e. <Insert manufacturer's name>.
2. Standard: UL 1474.
3. Pressure Rating: [250-psig (1725-kPa) minimum] [300 psig (2070 kPa)].
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.

7. Inlet and Outlet: Threaded.

2.05 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Globe Fire Sprinkler Corporation.
 2. Reliable Automatic Sprinkler Co., Inc. (The).
 3. Tyco Fire Products LP.
 4. Victaulic Company.
 5. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.
- D. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
 1. Early-Suppression, Fast-Response Applications: [UL 1767]
 2. Nonresidential Applications: [UL 199]
 3. Residential Applications: [UL 1626]
 4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- F. Sprinkler Finishes: Chrome plated and bronze.
- G. Special Coatings: corrosion-resistant paint.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Chrome-plated steel, one piece, flat Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment.
- I. Sprinkler Guards:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.

- d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.02 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.

- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.03 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.04 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.05 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.06 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Align sprinklers in coordination with light fixtures and other ceiling mounted objects in accordance with the design plans and in coordination with the Architect. Architect shall approve deviations from design plan.

3.07 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Coordinate with fire-alarm tests. Operate as required.
 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.09 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [threaded ends, cast-iron threaded fittings, and threaded] [grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved] joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following:
 1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.

4. Standard-weight, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
 5. Standard-weight, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 6. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 7. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 (DN 65) and larger, shall be of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Standard-weight, black-steel pipe with [cut-] [or] [roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 7. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

3.11 SPRINKLER SCHEDULE

- A. Use sprinkler types in 28 13 00 based on area of use and finish expectations. Final direction on sprinkler type to be coordinated with AOR and the District.

END OF SECTION

SECTION 21 13 16

PRE-ACTION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Cover system for sprinkler piping.
 - 3. Specialty valves.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.
- B. Related Requirements:
 - 1. Section 211300
 - 2. Section 211313
 - 3. Section 283101

1.03 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

1.04 System Description

- A. Supply and install a fail-safe double interlocked pre-action system/riser/cabinet containing all hydraulic and electrical components required for the control of a fail- safe pre-action system.
- B. Pressure gauges to indicate water supply, priming water and air pressures of the system. Each pressure gauge must be provided with its own shut-off valve and shall be clearly identified on the outside of the cabinet front door.
- C. Schedule 40 galvanized steel release trim with solenoid valves and every supervisory and alarm device required.
- D. Schedule 40 steel pipe header painted fire red, with grooved ends to be connected to supply water from either side.

- E. Schedule 40 steel pipe drain manifold of 2" diameter painted fire red, with grooved ends for drain connections from either side.
- F. Properly identified contractor test ports factory mounted into the trim piping to facilitate system testing and commissioning.

1.05 System Operation

- A. Contractor should make sure the remote release control panel sequence of operation is programmed to perform the following:
 - 1. The activation of both the detection condition AND the opening of an automatic sprinkler are necessary to cause the water discharge.
 - 2. The activation of an electrical detector alone will sound an alarm and activate alarm contacts for auxiliary functions but will not cause the system to fill with water.
 - 3. The opening of an automatic sprinkler OR damage to system piping without the detection condition satisfied will activate the very low air pressure switch zone, sound an alarm, and activate alarm contacts for auxiliary functions but will not cause the system to fill with water.
 - 4. Activation of BOTH the detection condition AND the opening of an automatic sprinkler will activate the solenoid valves, open the deluge valve, and cause water to discharge. This will sound an alarm and activate alarm and water flow contacts for auxiliary functions.
 - 5. Operation of the emergency manual release will depressurize the priming chamber of the deluge valve, causing the system to fill the piping network with water, and activate alarm and water flow contacts for auxiliary functions.
 - 6. If the AC Power fails and the battery backup power expires before an alarm is detected, the pre-action system should "fail-safe" and function as a dry pipe system. The opening of an automatic sprinkler OR damage to system piping will cause the system to fill and flow water until it is manually shut-off.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For pre-action sprinkler systems.
 - 1. Include plans, elevations, sections, riser diagrams and attachment details and all applicable documentation required by NFPA 13 and NFPA 72 for working drawings.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from design engineer, sub-contractors and installers of the items involved:
 - 1. Domestic water piping.
 - 2. Compressed air piping.
 - 3. HVAC hydronic piping.
 - 4. Structural Members.

5. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - B. Qualification Data: For qualified Installer, NICET Level IV Designer and professional engineer.
 - C. Design Data:
 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
 - D. Welding certificates.
 - E. Field Test Reports:
 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 2. Fire-hydrant flow test report.
 - F. Field quality-control reports.
- 1.08 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For pre-action sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.
- 1.09 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
- 1.10 QUALITY ASSURANCE
- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
 - B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.
- 1.11 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
1. Notify Architect and Owner/District no fewer than three days in advance of proposed interruption of sprinkler service.
 2. Do not proceed with interruption of sprinkler service without Architect's and Owner's written permission.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13.
 2. California DSA.

2.02 Supply to release control panel

- A. Supply and install a second branch circuit, 110VAC, 60Hz for each of air compressor provided inside the pre-action cabinet by the factory.
- B. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
1. Available fire-hydrant flow test records indicate the following conditions:
 - a. Date: 6/30/2021.
 - b. Time: 8:30 a.m
 - c. Performed by:.
 - d. Static Pressure at Residual Fire Hydrant XXXX: psig.
 - e. Measured Flow at Flow Fire Hydrant Y: gpm.
 - f. Residual Pressure at Residual Fire Hydrant X: psig.
 2. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) IT/MPOE/MDF/BDF: Light Hazard
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.

4. Maximum Protection Area per Sprinkler: According to UL listing.
5. Maximum Protection Area per Sprinkler:
 - a. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m)
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and California DSA.

2.03 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B . Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Cast-Iron Flanges: ASME 16.1, Class 125.
- E. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Grooved-Joint, Steel-Pipe Appurtenances:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products USA Inc.
 - e. Smith-Cooper International.
 - f. Tyco Fire Products LP.
 - g. Victaulic Company.
 2. Pressure Rating: 175-psig (1200-kPa) minimum.
 3. Galvanized, Painted, and Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.04 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Deluge Valves
 - 1. Deluge Valve complete with releasing trim rated at 250 psi and all the necessary accessories. Trim shall include a mechanical latching device to prevent system from resetting in case of loss of power to the release solenoids. Systems provided with solenoids only, without this mechanical latching device, shall not be accepted. Every valve shall be clearly identified as to its operation with arrows indicating all positions to facilitate system operation.
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. Viking Corporation or equivalent
 - b. Standard: UL 260.
 - c. Design: Electrically operated, differential-area type.
 - d. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
 - e. Fail-safe self-contained double interlocked pre-action cabinet containing all hydraulic and electrical components required for the control of a fail-safe pre-action system. Air compressor and supervisory trim (Air Supply Style "A") shall be provided inside the cabinet and its pressure factory adjusted for the selected configuration.
 - 3. Air Compressor:
 - a. The automatic sprinkler piping is supervised by compressed air from a source installed to serve the system.
 - b. The air supply must be regulated and of the proper size in order to be able to restore normal system air pressure within 30 minutes.
 - c. Manufacturers: Subject to district approval,

2.05 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products USA Inc.

- d. Tyco Fire Products LP.
- e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175-psig (1200-kPa)
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aegis Technologies, Inc.
 - b. CECA, LLC.
 - c. Corcoran Piping System Co.
 - d. Merit Manufacturing.
 - e. <Insert manufacturer's name>.
2. Standard: UL 1474.
3. Pressure Rating: [250-psig (1725-kPa) minimum] [300 psig (2070 kPa)].
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

2.06 SPRINKLERS

A.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco Fire Products LP.
4. Victaulic Company.
5. Viking Corporation.

C. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

D. Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.

E. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.

- F. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: [UL 1767]
 2. Nonresidential Applications: [UL 199]
 3. Residential Applications: [UL 1626]
 4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- G. Sprinkler Finishes: Chrome plated and bronze.
- H. Special Coatings: corrosion-resistant paint.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment.
- J. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 199.
 3. Type: Wire cage with fastening device for attaching to sprinkler.
- K. Pressure Switches:
- Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1. Potter Electric Signal Company.
 2. Viking Corporation.
 3. Or Equal
 - a. Standard: UL 346.
 - b. Type: Electrically supervised water-flow switch with retard feature.
 - c. Components: Single-pole, double-throw switch with normally closed contacts.
 - d. Design Operation: Rising pressure signals water flow.
- L. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements,
 - a. Potter Electric Signal Company.
 - b. Viking
 - c. Standard: UL 346.
 - d. Type: Electrically supervised.
 - e. Components: Single-pole, double-throw switch with normally closed contacts.
 - f. Design: Signals that controlled valve is in other than fully open position.

2.10 CONTROL PANELS

- A. Description: Single-area single-s-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM Global approved

- a. The control panel shall be FM Approved and c-UL-us Listed to the new UL 864-9 standard. Panel shall include four programmable Class B, Style B initiating zones, two class B supervisory zones, and four programmable output circuits. Onboard, menu-driven programming with twelve pre-installed programs for ease of set-up must also be provided. The panel must be compatible with many different initiating devices including linear heat detection, smoke and heat detectors, water flow indicators, low air pressure switches, and manual pull stations.
 - b. The control panel should include both an LCD Annunciator describing all system conditions (16 characters on 2 lines) and a set of red & yellow LED lamps identifying each separate alarm and trouble conditions. Easy to operate control buttons shall also be included for the operation of the panel various functions.
 - c. A set of emergency batteries should be provided with the control panel. Batteries should be calculated to provide emergency power for a specific duration after which they shall be able to provide 5 minutes of alarm and activation of the solenoid valve(s). 10 minutes of alarm after 90 hours stand-by (FM).
 - f. Supply and install one dedicated 110VAC, 60Hz branch circuit to power each release control panel.
 - g. Supply and install a second branch circuit, 110VAC, 60Hz for each air compressor provided inside the pre-action cabinet by the factory.
 - h. The (two) independent circuit(s) for each pre-action systems shall be well identified and their circuit breaker locked.
2. Supply and install a partial electrical detection system programmed for addressing multiple detection zones including:
 - a. system tubing, wiring, smoke detectors, signaling devices and connections to auxiliary functions.
 - b. Smoke detectors shall be provided and wired to the Notifier NFS 320 remote release control panel by others. Spacing and type of detectors shall meet the requirements of the applicable standards and the manufacturer's recommendations for the application protected.
 - c. Detection and alarm indicating devices (24 Vdc bell, horn or strobe) must be compatible with the remote release control panel. In addition, contractor

PART 3 EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.02 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.03 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.04 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.05 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.06 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Align sprinklers in coordination with light fixtures and other ceiling mounted objects in accordance with the design plans and in coordination with the Architect. Architect shall approve deviations from design plan.

3.07 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Coordinate with fire-alarm tests. Operate as required.
 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- 3.09 CLEANING
- A. Clean dirt and debris from sprinklers.
 - B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.
- 3.10 PIPING SCHEDULE
- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [threaded ends, cast-iron threaded fittings, and threaded] [grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved] joints.
 - B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
 - C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following:
 1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 4. Standard-weight, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
 5. Standard-weight, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 6. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 7. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 (DN 65) and larger, shall be of the following:
 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. Standard-weight, black-steel pipe with [cut-] [or] [roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

3.11 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers in- stead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 2. **Dry-Pipe** Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 3. Install air compressor and compressed-air supply piping.

Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with adjustable range; and maximum inlet pressure.

4. Install compressed-air

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in 28 13 00 based on area of use and finish expectations. Final direction on sprinkler type to be coordinated with AOR and the District.

END OF SECTION

SECTION 21 22 00

CLEAN AGENT FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Each room to be protected shall be considered a single zone for fire suppression protection.
- B. The quantity of the agent shall be that necessary to maintain a concentration capable of extinguishment/fire suppression for at least ten minutes. Such factors as unclosable openings (if any), "rundown" time for fans, time required for dampers to close, and all other features of the facility that could affect concentration shall be considered.
- C. Design and operation of the system shall comply at a minimum with the appropriate requirements of NFPA 2001 and the requirements of the nationally recognized testing authorities for which listings or approvals have been obtained.
- D. Fire Protection System: Total flooding of hazard area with fire extinguishing agent, to extinguishing fire.
- E. Locate extinguishing agent supply and back-up supply in a 1-hour rated room adjacent to each hazard area or within the hazard area.
- F. System shall be fixed installation with equipment designed and installed to provide fire-extinguishing capability for the area as indicated.

1.02 REFERENCES

- A. California State Fire Marshal (CSFM):
 - 1. Building Materials Listing Program
- B. National Fire Protection Association
 - 1. NFPA 70
 - 2. NFPA 72
 - 3. NFPA 75
 - 4. NFPA 2001

1.03 SUBMITTALS

- A. Refer to applicable General Sections of this specification, submittal procedures, shop drawings, project data and samples for submittal requirements.
- B. Shop Drawings and Data
 - 1. All drawings and calculations shall be prepared in accordance with NFPA 2001. Refer to Article entitled "Quality Assurance" herein for requirement that drawings and calculations be signed and stamped by professional engineer.

2. Drawings shall bear stamp of approval of authority having jurisdiction and shall indicate locations, installation details, and operation details of all equipment and piping, control diagram, wiring diagram and sequence of operation associated with the fire suppression system.
3. Piping plan view and detail drawings shall be drawn to scale and isometrics dimensioned to show the entire storage and distribution system, the nozzle and detector location, and layout of annunciator final graphics. The detector and nozzle locations shall be coordinated with lighting fixtures, diffusers, ductwork, and other equipment installed in the protected room. Indicate manual pull station, control panel, and accessory locations and details.
4. Electrical drawings shall indicate the complete sequence of operations of the system, termination diagrams and locations of interfaces with other systems.
5. Calculations shall be submitted demonstrating that the proposed system can provide the design concentration within the design discharge time. Submit design calculations bearing stamp of approval of authority having jurisdiction.
6. Calculations shall be submitted showing required battery capacity, verify system pressure, nozzle flow rate, orifice code numbers, piping pressure losses, component flow data and pipe sizes.
7. Indicate any required construction phasing.
8. DSA: Shop Drawings of the clean agent fire suppression system shall be submitted to the Engineer for submission to the Division of the State Architect for approval. Include State Fire Marshal listing numbers, as listed in the State Fire Marshal's Building Materials Listing Program, for all components. Shop Drawings require approval of the DSA before any installation work may begin.
9. Certificates of Compliance: Submit certified test reports for materials and equipment to demonstrate compliance with specification requirements
10. Product Data: Material and equipment information shall include manufacturer's catalog cuts and technical data for each of the following components or devices used in the system and shall bear stamp of authority having jurisdiction
 - a. Smoke detection;
 - b. Manual discharge switches (pull stations);
 - c. Control panel;
 - d. Release devices;
 - e. Alarm devices;
 - f. Storage containers;
 - g. Mounting brackets;
 - h. Nozzles;
 - i. Abort stations; and
 - j. Contact monitor modules.
11. Operation and Maintenance Data: Submit operation and maintenance data for the equipment and system provided in accordance with Section 01 78 23, Operation and Maintenance Data. Include recommended spare parts list.
12. Certified Test Reports: Submit certified test reports that indicate successful completion of all tests performed as required by Article 3.04 herein.
13. Manufacturer: Certify that system meets or exceeds specified requirements and NFPA 2001.

1.04 QUALITY ASSURANCE

A. Qualifications of the System Designer and Installer

1. The system installer or sub-contractor for this work shall possess a valid C-16 California Contractors license. The fire suppression systems must be installed by an experienced and qualified individual or firm regularly engaged in clean agent fire suppression system design and installation. Drawings and calculations must be signed and sealed by a registered California Profession Fire Protection Engineer.
2. The installer shall maintain a 24-hour, seven-day-a-week telephone number for emergencies. Factory-trained personnel shall be kept on call for emergency service at all times.
3. Identification of Materials and Equipment: Materials and equipment shall be clearly marked or stamped with the manufacturer's name, nameplate data or stamp, rating, and conformance with corresponding standard number, as applicable.
4. Perform work in accordance with NFPA 70 and NFPA 72, applicable UL standards and requirements of applicable codes and ordinance.
5. Indicate manufacturer's name and pressure rating on valve body. Indicate manufacturer, type and size, part number, orifice code or orifice diameter on discharge nozzles. Markings shall be standard and visible after installation.
6. Certified Tests and Listings: Fire protection material and equipment shall be approved or listed by a nationally recognized testing laboratory of fire protection equipment for this application.
7. Equipment and devices of the system shall be of identical type, model and manufacturer as submitted and shall be approved by the California State Fire Marshal.

1.05 DESIGN REQUIREMENTS

A. Provide sufficient amount of fire extinguishing agent liquid to convert into fire extinguishing agent vapor. Consider the following when computing volume:

1. Volume of hazard area.
2. Specific volume of fire extinguishing agent vapor.
3. Additional quantities of fire extinguishing agent required to compensate for openings, pipe losses, and nitrogen dilution.
4. Forced ventilation, fan coast-down time, and damper actuation time.
5. Mechanical smoke control system.
6. Other special conditions affecting extinguishing efficiency.
7. Interface system with building fire alarm system.
8. Manufacturer Qualification: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

B. Design system under direct supervision of a California licensed professional engineer experienced in design of this work.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for system design, fabrication, and installation.

B. Conform to NFPA 70 and NFPA 72 code for electrical wiring and wiring devices.

- C. Provide certification of inspection approval of fire protection system by authority having jurisdiction.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., and acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Refer to Section 01 60 00, Product Requirements, for requirements. Transport, handle, store, and protect products.
- B. Accept materials and components on site in shipping containers. Inspect for damage.
- C. Delivery and store equipment in shipping containers with labeling in place. Deliver fire-extinguishing agent in approved containers.
- D. MAINTENANCE SERVICE
- E. Refer to Section 01 77 00, Closeout Procedures, for requirements.
- F. Conduct inspections 6 months and 12 months from date of Substantial Completion to verify proper operation of system and to check agent container weight and pressure. Include a thorough check of controls, detection and alarm systems.
- G. Submit documents, certifying satisfactory system conditions. Include manufacturer's certificate of acceptance of Inspector's qualifications.

1.08 SITE CONDITIONS

- A. Inspect surfaces and structures where the system components will be anchored or fastened before the work of this Section begins. Determine that surfaces and structures are capable of supporting the system components and their weight.
- B. Coordinate the installation of the system with the station alarm and detection system and other systems and components, pipes, and conduits, so as to avoid conflicts of space and installation.

PART 2 - PRODUCTS

2.01 ALARM OPERATION DESCRIPTION

- A. Alarm Phase I: One hundred percent smoke density at any sensor shall trigger or activate equipment functions as follows:
 1. Annunciate the device status and its location at the system control panel;
 2. Cause a pre-alarm audio-visual (horn) to slow modulate within the protected zone;
 3. Send an alarm signal via dry contact closure to the station fire alarm control panel provided under Section 28 31 00, Fire Detection and Alarm System; and
 4. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis.
 5. Shut down air conditioning system and close dampers.

- B. Alarm Phase II: One hundred percent smoke density at any second sensor within the same protected area shall trigger or activate equipment functions as follows:
1. Annunciate the device status and its location at the system control panel;
 2. Cause a pre-discharge audio and visual alarm (horn) to fast modulate within the protected zone;
 3. Send a pre-discharge signal via dry contact closure to the station fire alarm control panel provided under Section 28 31 00, Fire Detection and Alarm System;
 4. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis; and
 5. Activate a thirty-second time delay.
- C. Alarm Phase III: Agent Discharge:
1. After the 30-second time delay has expired the initiator shall be activated to release the fire-extinguishing agent.
 2. Upon discharge, warning horn and lights shall activate continuously at all entrances to the protected area.
 3. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis.
- D. Manual Station Operation:
1. Requirements: The system shall be capable of being actuated by manual discharge switches for the protected area. Operation of a manual discharge.
 2. switch shall cause alarm devices and shutdown functions to operate immediately. Manual stations used to release agents shall require two separate and distinct operations. The manual discharge switch shall override the time delay and abort capabilities of the system. Manual discharge switches shall be provided in the protected area at all of the exits. Each manual station shall be addressable and activation of these devices shall provide custom information at the station fire alarm control panel.
 3. Pull Stations: Surface housing fitted with double action control fitted with "push- in" tab and "pull-down" lever that locks in position after releasing spring-loaded contact, for mounting on electrical outlet box.
- E. Labeling: Locate engraved label adjacent to each manual pull station indicating area protected, and that actuation will cause discharge of fire extinguishing agent.
- F. TROUBLE OPERATION DESCRIPTION
1. Trouble Conditions: The fire detection system shall provide the following sequence of operation for any trouble condition:
 2. Display a custom message identifying the device in trouble.
 3. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis.
 4. Send a trouble signal via dry contact closure to the station fire alarm control panel provided in accordance with Section 28 31 00, Fire Detection and Alarm System.

2.02 MATERIALS AND EQUIPMENT

- A. General Requirements:

1. Equipment and accessories furnished hereunder shall be standard components of a specified manufacturer. Catalog numbers and model designations shall indicate design, quality, and type of material as well as required operating characteristics.
 2. Field fabricated equipment not supplied by the manufacturer will not be accepted unless approved by the Engineer.
 3. Locks for cabinets shall be keyed alike.
- B. Control and Supervisory Systems:
1. System Control Panel: (Red in color)
 - a. The system control panel shall be red in color, and shall process all input signals, sequence the levels of alarms, and provide outputs to the extinguishing agent storage containers.
 - b. Auxiliary outputs and dry contacts shall be available to shut down fans, activate dampers, contact other agencies, or annunciate to remote devices. The system shall have standby batteries and charger for continuous operation of detection, alarm, actuation, and supervision function to provide a minimum of 24 hours of emergency power. The system control panel shall provide for either a Style "D" or a Style "B" (allowing T-Tapping) as defined in NFPA 72, type wiring and shall utilize initiating devices connected in parallel to provide automatic battery switch- over upon failure of primary power supply.
 - c. The system control panel shall utilize parallel agent release modules as a method of discharging the agent. The operation of a discharge signal shall immediately cause the appropriate agent release modules to activate and release agent. The initiator circuit shall be a parallel Style "D" circuit. Any system utilizing series initiators, series solenoids or mechanically activated solenoids is unacceptable. All initiator wiring shall be fully supervised.
 2. Central Control Module (CCM): This module shall control, supervise, and continuously monitor the entire system through the use of an industrial grade 32-bit micro controller. This module shall include a backlit liquid crystal display
 - a. (LCD) with minimum 200 alphanumeric characters that provide individual custom messages associated with every addressable device in the system. The CCM shall include touch membrane switches for each of the following:
 - b. Location: Display a 100-character custom message associated with the individually addressable devices reporting to the CCM or a manufacturer- specified message for devices (i.e. door holders, air conditioning units) supervised and controlled by the CCM.
 - c. Next Trouble: Displays the chronological sequence of individual addressable devices in trouble reporting to the CCM or a manufacturer-specified message for devices supervised and controlled by the CCM.
 - d. Next Alarm: Displays the chronological sequence of individual addressable devices in alarm reporting to the CCM.
 - e. History Buffer: The CCM shall contain a 256-event nonvolatile history buffer. This history shall be retrieved by downloading the information through an internal RS232 port, and USB port to a personal computer and printer without having to purchase additional software.
 - f. Field Programming: This system shall be fully field programmable and shall not require factory assistance for reconfiguration of any kind.
 - g. Expansion Capability: To allow for future expansions, the central control module shall be capable of connecting a minimum of 1,016 individual addresses.

- h. Approved as alarm and releasing device, with solid-state internal circuitry enclosed in NEMA ICS 6, Type 1 cabinet.
 - i. Provide supervision to NFPA 72, Class A of the following circuits for wire break or ground faults:
 - 1) Zone detection loops.
 - 2) Remote manual discharge stations.
 - j. Suppression system solenoid valves.
 - k. Power supply and circuit wiring and fuse.
 - l. Battery interconnecting wires and fuse.
 - m. Alarm in abort mode.
 - n. Equip panel with following standard features:
 - o. Visual and audible annunciation of trouble or alarm signals.
 - p. Panel reset switch.
 - q. Trouble alarm silence switch with ring back feature.
 - r. Single Zone Detection: Cross zone (optional).
 - s. Battery test meter and switch.
 - t. Manual discharge switch.
 - u. Deadman abort switch.
 - v. Programmable timers for pre-discharge and discharge, 0-60 second cycle.
 - w. Isolated relay contactors for external alarm or equipment and ventilation shutdown.
 - x. Relay contactors for general trouble signal.
 - y. Relay contactor activated by detector zone board in alarm or trouble mode.
3. Operating Sequence:
- a. Actuation of one detector in either zone circuit:
 - 1) Illuminate zone indicator.
 - 2) Energize alarm bell.
 - 3) Shut down air-conditioning system and close dampers.
 - 4) Close doors to area.
 - 5) Signal building fire alarm system via dry contact.
 - b. Actuation of second detector on second zone circuit:
 - 1) Illuminate zone indicator.
 - 2) Energize alarm horn.
 - 3) Shut down power to protected equipment
 - 4) Actuate time delay for up to (30) (60) seconds.
 - 5) Release extinguishing agent into protected area.
 - 6) If abort switch is engaged, delay release.
 - 7) Upon abort switch disengagement release extinguishing agent unless system cleared and reset.

- 8) Signal building fire alarm system via dry contact closure.
 - c. Discharge of Extinguishing Agent:
 - 1) Sounds alarm bells and horns.
 - 2) Operates strobes.
 - d. Temperature Detection:
 - 1) Lower Temperature: Illuminate indicator and energize (bell) (horn).
 - 2) Higher Temperature: Shut down power to protected equipment.
 - e. Manual Discharge Station: Manual discharge stations shall have a dual action release configuration to prevent accidental system discharge. The legend on the front of the station shall read "Agent-Release". These stations shall be located at emergency fire exits. A contact monitor module will be included with each station to give it a specific address (location) through the CCM.
 - f. System Abort Switch: The switch shall be a momentary deadman-type, that when depressed, interrupts the automatic sequence of the control system and prevents agent discharge. Each switch shall be permanently labeled "System Abort". These stations shall be located at emergency fire exits. A contact monitor module shall be included with each switch to give it a specific address (location) through the CCM.
4. Verified Detection Sensors:
 - a. The photoelectric sensors shall be spaced and located, in accordance with the manufacturer's specifications and with the guidelines of NFPA 72. Detector coverage shall not be greater than 250 square feet per detector.
 - b. The system control panel shall provide the command and interrogation signals that confirm an alarm by comparing (with consecutive multiple passes of the "interrogation window") sensor information with stored data on fire conditions. The analog or addressable photoelectric sensor shall provide true linear analog data to the CCM in order for the CCM to differentiate between higher and lower values of smoke density and to establish a working range of sensitivity levels unique to the particular environment. Adjustments needed for sensor sensitivity to meet ambient conditions shall have a minimum of 12^olevels of adjustment.
 - c. The system shall have the capacity to automatically conduct a weekly functional test of each sensor, that is accomplished by means of a test LED fitted within each sensor. When automatically activated by the control panel this test LED shall produce an infrared signal level directly equivalent to that reflected by a given percentage of smoke entering the chamber. Any sensor not responding to its preset limits shall be automatically readjusted to a programmed level of sensitivity.
 5. Alarm Signal Outputs:
 - a. Outputs shall be provided from the system control panel for interface with station fire alarm control panel.
 - b. Audible and visual alarm horn and strobes: The alarms shall operate on 24-volt polarized DC power and allow for supervision. The alarm unit shall have a minimum sound level of 97 decibels at 10 feet. All strobes including both in the protected room and outside room, shall be capable of
 - 1) 100 candelas.
 6. Fire Suppression Agent:

- a. The agent shall be fluoroketone, such as 3m Novec 1230 or equal, or heptafluoropropane, HFC-227ea. The physical and chemical properties shall conform with the requirements of NFPA 2001.
 - b. The agent shall be stored in containers, super-pressurized with nitrogen to a maximum total pressure level at 70 degrees Fahrenheit of 360 psig.
 - c. Higher-pressure agents will not be accepted. Agents stored at pressure higher than 360 psig shall be contained in a safe manner and approved by the Engineer.
 - d. The agent shall have the following characteristics:
 - 1) Ozone depletion potential of zero;
 - 2) Atmospheric lifetime less than 50 years; and c. 4-hour LC50 > 788,696 ppm
7. Agent Storage and Distribution Components:
- a. Agent Storage Containers:
 - 1) Standard model and size for ease of replacement and addition. Design, fabricate, certify, and stamp cylinders in accordance with ASME Section VIII.
 - 2) The supply area of agent shall be central storage by design. The storage vessels shall be capable of being refilled in the field and checked for liquid level without the aid of scales or other special tools.
 - 3) The supply shall be located as indicated, so that proper hydraulic agent distribution is achieved. Agent storage containers shall be floor mounted and shall include bracket assemblies designed to withstand 1000 pounds thrust for 10 seconds. Floor space is limited, therefore, alternatives requiring more floor space will not be considered.
 - 4) The storage containers shall be actuated by means of an electronic initiator. Each container shall be actuated individually. Master and slave solenoid configurations will not be considered.
 - b. Identification: Permanent plate, specifying agent, tare and gross weight, pound of fire extinguishing agent, and pressurization level, installed so that plate is visible and readable.
 - c. Cylinder valves: Heavy duty forged brass, incorporating safety release pressure operated manual control, solenoid discharge valve, and pressure gage. Provide solenoid pilot valves for each cylinder or bank of cylinders.
 - d. Manifold: Provide for systems with more than one cylinder with rack to secure each cylinder and check valves between each cylinder discharge and manifold.
 - e. The container and valve shall be capable of releasing the agent as fast as possible and shall not exceed 10 seconds.
 - f. A nameplate indicating the manufacturer's name and part number, agent fill weight, and total charged weight shall be permanently bonded to each container.
8. Safety Release: Equip cylinder with frangible disk safety device.
- a. The release valve shall accommodate a "straight through" vertical discharge with no directional changes for maximum discharge efficiency and safety. The releasing valve shall contain a "fast-acting" scored, non-fragmenting rupture membrane, which will burst when the pyrotechnic initiator is activated via an electric signal from the control panel.
 - b. Actuator: Release of the agent shall be accomplished by an electrical signal from the system control panel in conjunction with a specifically designed agent release module. Systems that employ more than one cylinder shall have all electric initiators connected in parallel.

9. Low Pressure Switch:
 - a. The agent storage container shall be equipped with a low-pressure switch to indicate a loss of container pressure. A decrease in pressure from 360 psi to 275/272 psi will cause the normally closed contact to open, thereby indicating a trouble condition.
 - b. Low pressure switch shall be monitored by the system control panel and shall provide a specific indication of cylinder low pressure.
 - c. Liquid Level Indicator: Tanks holding in excess of 60 pounds of agent shall contain a liquid level indicator to monitor vessel contents, in addition to the low-pressure switch.
10. Discharge Nozzles:
 - a. Nozzles shall distribute the agent throughout the protected area. Single nozzle shall not discharge more than 250 pounds of agent.
 - b. The nozzles shall utilize a 180 or 360-degree pattern and shall be designed to direct the discharge of agent parallel to the ceiling, thus minimizing the possibility of disturbance to objects within the room.
 - c. Construction: One-piece brass or aluminum nozzle with textured finish with female pipe thread integral on body. Direct discharge parallel to ceiling.
 - d. Identification: Permanently mark nozzles to show equivalent single orifices diameter.
11. Signs and Identification
 - a. Provide signs and identification as specified in Section 20 40 13, Identification for Facility Services, and in conformance with NFPA 2001
 - b. Provide signs and identification to each valve required to be identified.
 - c. Provide engraved nameplates for all manual discharge stations and abort switch locations to indicate their function. All alarm devices shall have similar identification plates.
 - d. Each entrance door shall include a caution placard indicating that the area is being protected by a clean agent fire suppression system. Where placards and signs are located outdoors, they shall be weather and UV resistant.
12. Wire and Conduit:
 - a. Wire: No. 14 awg copper wire conforming with the requirements of Section
 - b. 26 05 24, Low and Medium Voltage Wires and Cables, with insulation rating of 300 volts and temperature rating of 105 degrees Celsius. Provide power limited fire protective signaling cables conforming with the California Electrical Code, Articles 725 and 760, Type FPLR.
 - c.
 - a. Unavoidable splices shall be crimp-connected. Wire nuts will not be accepted.
 - d. Conduit: Galvanized rigid steel conduit, fittings, and accessories conforming to the requirements of Section 20 50 13, Raceways for Facility Services

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation Standards: Comply with applicable requirements of the NFPA 2001 and the California Electrical Code.

- B. System Installation Requirements: The fire suppression system shall be installed by the manufacturer or its authorized representative as indicated and in accordance with the approved Shop Drawings and the manufacturer's installation instructions and recommendations.
- C. Wiring shall be installed in galvanized rigid steel conduit, except that galvanized steel flexible conduit may be used for short runs where necessary for movement of devices.
- D. Wiring shall be installed to conform with the requirements of the California Electrical Code, Article 725B for Class 1 Signal Systems, except as otherwise permitted for limited energy circuits, as specified in NFPA 72.
- E. Securely support piping (in accordance with ASME B31.1) with allowance for fire- extinguishing agent thrust forces; thermal expansion and contraction; and longitudinal and lateral movement.
- F. Use grooved mechanical couplings and fasteners only in accessible locations. Roll groove piping only.
- G. Install unions downstream of valves and at equipment or apparatus connections.
- H. Prepare pipe, fittings, supports, and accessories for finish painting, in accordance with Section 09 91 00, Painting.
- I. Identify in accordance with NFPA 2001 requirements. Refer to Section 20 40 13, Identification for Facility Services. Place directional arrows and system labels wherever piping changes direction and minimum 20 feet (6 m) on straight runs.
- J. Secure cylinders as indicated on Drawings. (Where manifolded, mount and support by rack as indicated. For each system provide same size cylinders containing equal amounts of liquid).
- K. In rooms with suspended ceiling tiles, clip or retain tiles within 4-foot (1.2 m) radius of the nozzles to prevent lifting during discharge.
- L. Install wiring in accordance with Section 26 05 24, Low and Medium Voltage Wire and Cables, requirements.
- M. Make final connections between equipment and system wiring under direct supervision of factory trained representative of manufacturer.
- N. Install engraved plastic instruction plate or permanently bonded label, detailing emergency procedures, at control panel and at each manual discharge and abort switch location. At control panel identify control logic units, contacts, and major circuits with permanent nameplates.
- O. At hazard area walls pack space between pipe, pipe sleeve or surface penetration with mineral fiber with elastomer caulk to depth 1/2 inch (13 mm). Provide escutcheons where exposed piping passes through walls, floors, and ceilings. Seal pipe penetrations of fire separations. Refer to Section 07 90 00, Joint Protection.
- P. Locate discharge nozzle approximately 6 inches (150 mm) above or below wall header or ceiling level and 6 inches (150 mm) below raised floors. Avoid interference with other piping and equipment.
- Q. Locate remote manual releases at one or more doors to protect area where indicated. Locate deadman abort switch.
- R. Locate strobe units at all points of entrance to protected area.

- S. Locate abort station at all points of exit from protected area.
- T. Ream pipe and tube ends. Remove burrs. (Bevel plain end ferrous pipe.) Remove scale and dirt on inside and outside before assembly. Blow out pipe before nozzles or discharge devices are installed.
- U. Route piping in orderly manner, concealed, plumb and parallel to building structure, and maintain gradient. Install piping to conserve building space, and not interfere with use of space and other work.

3.02 TESTS

- A. System Tests: Tests shall demonstrate that the operation and installation requirements of this specification have been met. Submit certified copies of tests as specified in Article 1.06.G herein.
- B. Functional Tests: Tests shall demonstrate that the entire control system functions as designed. All circuits shall be tested including automatic discharge, manual discharge, and equipment shutdown and alarm devices. In addition, supervision of each circuit shall be tested.
- C. Design Review Test: Take field measurements of the room, and field calculate the amount of clean agent required to reach the design criteria, and match against the contents of the clean agent storage containers.
- D. Pressurization Test: Conduct a door fan test to determine the overall containment capacity of the clean agent protected area, and equivalent leakage area of the room. The calibrated fan unit shall be used to pressurize or depressurize the area with all air conditioning shutdown and dampers closed, and monitor airflow versus pressure data. The results shall be used to calculate a pass or non-pass conclusion. A manufacturer-approved testing unit and program shall be used for this test.
- E. Piping Test Review: Make a field verification of the piping network and match against the drawing flow calculations. All significant variations will require recalculation of the piping system.
- F. A distribution piping and valve, prior to nozzle installation pressurization test shall be conducted that requires 150 psi to be held for 10 minutes with no more than 10 percent pressure drop. Inspect joints using soap water solution or halide torch or lamp, replace and retest.
- G. A "puff" test using dry nitrogen shall be conducted. Caps shall be placed over all discharge nozzles and adequate pressure shall be supplied to demonstrate that all of the caps will blow off indicating that the pipes are free of obstructions.
- H. Upon completion of installation provide final checkout inspection by factory-trained representative of manufacturer to ascertain proper system
- I. operation. Leave system in a fully commissioned and automatic readiness state with circuitry energized and supervised.
- J. Submit original copies of tests, indicating that factory trained technical representatives of the manufacturer have inspected and tested systems and are satisfied with methods of installation, connections and operations.
- K. After successful testing, de-pressurize the system and remove nozzle caps without moving pipes, and install discharge nozzles without moving pipe assembly.

3.03 TRAINING AND INSPECTIONS

- A. Training Requirements: Provide complete system operation training of at least four hours for six of the District's maintenance personnel in accordance with
 - 1. Section 01 79 00, Demonstration and Training.
- B. Fire Suppression System Inspections:
- C. Provide two inspections of the system during the one-year warranty period. The first inspection shall be six months after system acceptance and the second after 12 months. Inspections shall include the determination of agent container weight and pressure and that the mechanical systems are in proper working order.
- D. Inspections shall also include a complete checkout of the control and alarm system and test, if possible that all interlocking systems are functioning properly.
- E. Documents certifying satisfactory system conditions shall be submitted upon completion of each inspection.

END OF SECTION

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SECTION 21 30 00

FIRE PUMPS

PART 1 GENERAL

1.01 REFERENCES

- A. FM Global System (FM) - Approval Guide.
- B. NEMA MG-1 - Motors and Generators.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).
- D. NFPA 20 - Installation of Centrifugal Fire Pumps.
- E. UL - Fire Protection Equipment Directory.
- F. UL 448 - Pumps for Fire Protection Service.
- G. UL 778 - Motor Operated Water Pumps.
- H. UL 1247 - Diesel Engines for Driving Centrifugal Fire Pumps.
- I. CCR California Code of Regulation
- J. CBC California Building Code
- K. CEC California Electric Code
- L. CMC California Mechanical Code
- M. CPC California Plumbing Code
- N. CFC California Fire Code

PART 2 PRODUCTS

2.01 VERTICAL IN-LINE PUMPS

- A. Type: UL 448 and UL 778, vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 250 psi. Fire pump shall be capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head. Factory assembled and tested to comply with NFPA 20.
- B. Casing: Cast or ductile iron, with suction and discharge gauge ports, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.

- C. Impeller: Bronze, fully enclosed, statically and dynamically balanced, keyed directly to motor shaft.
- D. Shaft: Solid alloy steel with bronze sleeve.
- E. Seal: Packing gland with minimum four rings graphite impregnated packing and lantern rings, 230°F maximum continuous operating temperature.
- F. Wear Rings: Replaceable, bronze.
- G. Finish: Manufacturer's standard red paint.
- H. Provide nameplate complete with rated capacities and pump characteristics.
- I. Performance: Refer to Schedule on drawings. Acceptable Manufacturers: Aurora Pumps, Fairbanks Morse, Peerless Pump, A-C Pump; ITT Industries, Patterson Pump.
- J. Controllers: Acceptable Manufacturers: Aquarius, Firetrol, Masters, Cutler-Hammer

2.02 HORIZONTAL BASE MOUNTED PUMPS

- A. Type: UL 448 and UL 778, horizontal shaft, single stage, double suction, direct connected, horizontally split casing, for 250 psi maximum working pressure. Fire pump shall be capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head. Factory assembled and tested to comply with NFPA 20.
- B. Casing: Cast iron, with suction and discharge gauge ports, renewable bronze casing wear rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, double suction, fully enclosed, balanced and keyed to shaft.
- D. Bearings: Grease lubricated ball bearings in cast iron housing.
- E. Shaft and Sleeve: Alloy steel with replaceable bronze shaft sleeve.
- F. Seal: Packing gland with minimum four rings graphite impregnated packing and lantern rings, 230°F maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.
- I. Finish: Manufacturer's standard red paint.
- J. Provide nameplate complete with rated capacities and pump characteristics.
- K. Performance: Refer to Schedule on drawings. Acceptable Manufacturers: Aurora Pumps, Fairbanks Morse, Peerless Pump, A-C Pump; ITT Industries, Patterson Pump.
- L. Controllers: Acceptable Manufacturers: Aquarius, Firetrol, Masters, Cutler-Hammer

2.03 ELECTRIC MOTOR DRIVE

- A. Motor: UL listed, squirrel cage induction type; in open drip-proof NEMA MG1 enclosure, 1750 3550 RPM complying with NFPA 20 and NFPA 70.
- B. Controller: UL 218 and NFPA 20, full-service type with solid state reduced voltage starter across the line starter VFD and electrical characteristics as scheduled on the drawings, in NEMA 3R enclosure, combined automatic and manual operation, factory assembled and wired, and factory tested for capacities and electrical characteristics, including the following:
1. Disconnect Means: Externally operable, quick-break type.
 2. Circuit Breaker: Continuous current rating not less than 115% of the rated full load current of the motor. Overcurrent sensing elements of the non-thermal type. Instantaneous short circuit current rating for 100,000 amperes interrupting capacity and service entrance rated.
 3. Locked Rotor Protection: Calibrated and set at a minimum of 300% of full load current.
 4. Motor Starter: Energized automatically by pressure switch or manually by externally operable handle.
 5. Pressure Switch: Water pressure actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire suppression piping. This Contractor is responsible for determining and setting start and stop pressures based on hydraulic calculations, available water pressure, required system pressure, controller manufacturer's recommendations, and NFPA requirements. If the fire pump is serving a sprinkler system, the activation of one sprinkler shall be sufficient to bring on the fire pump.
 6. Running Timer: Keeps motor operating when started automatically, for at least ten minutes.
 7. Pilot Lamp: Indicates circuit breaker closed and power available.
 8. Ammeter and voltmeter built into enclosure.
 9. Built-in Alarm: Energizes alarm to indicate circuit breaker open or power failure.
 10. Remote start switch relay.
 11. Contacts for monitoring PHASE LOSS, PHASE REVERSAL, PUMP RUNNING, and ALTERNATE SOURCE.
 12. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32 inch orifice in clapper or ground face union with non-corrosive diaphragm having 3/32 inch orifice.
 13. Automatic Transfer Switch connected to primary and alternate power source: UL 218 and UL 1008 and requirements for and attached to fire pump controllers. Include enclosure complying with UL 50, Type 2, with automatic transfer switch with rating at least equal to fire pump driver motor horsepower. Include ampere rating not less than 115 percent of motor full load current and suitable for switching motor locked rotor current. Instantaneous short circuit current rating for 100,000 amperes interrupting capacity and service entrance rated.
 14. Surge Protection: Provide a factory-installed listed surge protection device with the fire pump controller.

15. System Pressure Recorder: Digital type with memory.
16. Finish: Manufacturer's standard red paint.

2.04 DIESEL ENGINE DRIVE

- A. Diesel Engine: Conform to NFPA 1247, arranged for automatic operation, include overspeed/overcrank switch and drive, two contactor switches, low oil pressure and high- water temperature warning switches, and fuel shutoff solenoid with wiring terminating in junction box.
- B. Include the following engine accessories:
 1. Stub shaft.
 2. Oil bath air cleaner.
 3. Water cooled exhaust manifold.
 4. Heat exchanger.
 5. Mechanical speed governor.
 6. Fuel filter.
 7. Lube oil filter and bypass valve.
 8. Lube oil cooler and relief valve.
 9. Fuel pump.
 10. Instrument panel with tachometer, hour meter, oil pressure gauge, water temperature gauge, ammeter, hand speed control and start switch.
 11. Starting system including generator/alternator, starting motor and voltage regulator.
- C. Cooling Water System: Closed system with cooling water supply to heat exchanger from fire pump discharge. Include four shutoff valves (including bypass line), two strainers, pressure regulating valve, automatic solenoid valve and pressure gauge.
- D. Storage Batteries: Dual lead acid batteries with 100 percent standby reserve capacity. Provide all necessary cables and battery racks.
- E. Fuel System: 250 gallons , but not less than required by NFPA 20, above ground storage tank, fill pipe and cap, manual shutoff valve, flame arrestor, oil level gauge, braided bronze flexible connectors, seamless Type L copper tubing with flared joints. Provide secondary containment tank with capacity equal to fuel storage tank.
- F. Automatic Diesel Engine Controller: Enclosed in floor mounted 14-gauge steel housing, UL and NFPA 20 listed and labeled.
 1. Controller automatically starts fire pump from water pressure control switch or test switch.
 2. Stopping push button shall manually stop engine.

3. Under automatic conditions, controller alternates batteries automatically on each 15 second cranking cycle. Alarm sounds if engine is not started after six attempts.
 4. Dual built-in battery charger, UL 1236 listed, recharges both batteries within 24 hours. Chargers shall have automatic overload protection (current limiting). Provide individual voltmeters and ammeters for each battery.
 5. Include individual pilot lights and common alarm bell for:
 - a. Low engine oil pressure.
 - b. High engine jacket water temperature.
 - c. Failure to start automatically.
 - d. Charger failure.
 - e. Battery 1 failure.
 - f. Battery 2 failure.
 - g. Overspeed shutdown.
 6. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32 inch orifice in clapper or ground face union with non-corrosive diaphragm having 3/32 inch orifice.
- G. Remote Alarm and Signal Panel: Provide wall mounted panel in NEMA 3R Type 1 enclosure with:
1. Engine running light.
 2. Common engine failure light for:
 - a. Low engine oil pressure.
 - b. High engine jacket water temperature.
 - c. Failure to start automatically.
 - d. Charger failure.
 - e. Battery 1 failure.
 - f. Battery 2 failure.
 - g. Overspeed shutdown.
 3. Power on light.
 4. Switch off light indicating position of main control switch (off or manual).
- H. Exhaust System: ASTM A53/A53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe. Provisions shall be made for manually draining condensate from the silencer and exhaust piping.
1. Exhaust Connector: Flexible type.
 2. Exhaust Silencer: Residential type.
- I. Finish: Manufacturer's standard red paint.

2.05 PRESSURE MAINTENANCE (JOCKEY) PUMP

- A. Pressure Maintenance Pumps: Factory assembled and tested pumps with electric motor driver, controller, and accessories and specialties. Include cast iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.
- B. Electrically operated, horizontal turbine type with NEMA MG1, open drip-proof squirrel cage induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
- C. Provide suction and discharge pressure gauges.
- D. Provide with pressure relief valve and pipe to outdoors sump.
- E. Control by automatic jockey pump controller to start pump on pressure drop in system. Fire pump starts automatically on further pressure drop or on jockey pump failure.
- F. Controllers: UL 508, factory assembled, wired, and tested across the line type for combined automatic and manual operation.
 - 1. Enclosure: UL 508 and NEMA 250, Type 2, wall mounting type for field electrical wiring.
 - 2. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32 inch orifice in clapper or ground face union with non-corrosive diaphragm having 3/32 inch orifice.
 - 3. Rate controller for scheduled horsepower, and include the following:
 - a. Fusible disconnect switch.
 - b. Pressure switch.
 - c. Hand-off-auto selector switch.
 - d. Pilot light.
 - e. Running period timer.
 - 4. Finish: Manufacturer's standard color paint applied to factory assembled and tested unit before shipping.
- G. Performance: Refer to schedule on drawings.

END OF SECTION

DIVISION 22

PLUMBING

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SECTION 22 05 00

PLUMBING SYSTEM DESIGN CRITERIA

PART 1 GENERAL

1.01 DESIGN CRITERIA

A. General

1. The interface points between the Civil Design and the Plumbing Design will be at 5 feet outside the building wall.
2. All utilities shall enter each building above ground.
3. Each building shall have an isolation valve in the firewater and domestic line servicing each building.
4. The mains for any building shall not run through the building to the room where the isolation valve is located.
5. All outside isolation valves shall be located in a valve box. The box shall be arranged such that dirt does not fill the box over time and water shall not collect in the box.
6. All exposed piping and equipment in harsh environments shall be adequately protected.
7. No plumbing system or piping shall be located below raised floors.
8. Connections to dissimilar metals be avoided if at all possible and if this can't be avoided the connection shall be through the use of a dielectric connection.
9. Line size ball or gate valve shall be used. No butterfly valves shall be used.
10. All ball valves shall be so located for easy access and periodic exercise.
11. All exterior hose bibbs shall be recessed and have lockable doors.
12. All domestic water booster pumps shall be provided with a full line size bypass.
13. All pumping systems shall be provided with a discharge check valve.
14. Mop sinks and Janitor sinks in Hopper Rooms shall be provided with a second faucet for the chemical dispensing system. There shall be backflow preventers on the hot and cold water lines servicing the chemical dispensing system.
15. Locating any piping system under the slab on grade shall be avoided. A suggested separation of building systems to avoid maintenance issues is three feet.
16. Heat exchangers having a heat source from the mechanical boilers shall not be used.
17. The use of hot water storage tanks shall be limited.
18. Whenever possible water heaters shall be located on the first floor of any building. When water heaters are on a floor above the first, a pan shall be provided. The pan shall be drained to a floor sink through an air gap.

19. When a sewage ejector or sump pump are required, they shall be located for easy access and maintenance. Locating these outside the building is strongly suggested. There shall be a remote notification of power failure and for alarms. The location of the remote notification panel shall be specified by the campus.
20. Under counter acid neutralizers shall easily maintainable. Neutralizers with side access for are strongly suggested.
21. Central acid neutralizers shall be located for easy maintenance. Locating those requiring stone replacement outside are strongly suggested.
22. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, and function. Do not label exposed equipment in public areas.
23. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
24. Do not use one transformer to power multiple fixtures.
25. All equipment shall be located for easy maintenance.
26. Gas earthquake valves shall be provided on the exterior of each building.
27. Locate condensate pumps outside of sensitive areas.
28. The location of any piping or equipment shall not render access to another building system component inaccessible.
29. All penetrations through a roof shall be permanently sealed water tight.
30. Access panels shall be the lockable with a key. All access panels shall be keyed the same.
31. All wall access panels shall be 12" by 12".
32. All ceiling access panels shall be 24" by 24".
33. Wall access panels shall not be more than 4 feet high as measured to the top of the panel.
34. Access panel doors must be closable when the valve is in the closed position.
35. All reasonable efforts shall be to locate the access panels for restrooms in the men's restroom.

B. Storm Drainage Design

1. Storm drainage piping system will be sized in accordance with two (2) inches per hour of rainfall intensity.
2. The overflow drains will also extend from the roof however each of these will terminate at the exterior wall approximately 12 inches above the outside finished surface.
3. Overflow discharges shall not be onto a public walkway but rather through a fitting that takes the line under a walkway and discharges through a curb.
4. Both the piping for the storm drains and the piping for the overflow drains will be sloped at 2%.

5. There shall be a cleanout at the base of each storm drain riser prior to the final horizontal turn to connect to the site piping and cleanouts throughout the piping system as required by the Los Angeles City Plumbing Code.
6. Any groundwater drainage that will be collected below the elevation of city gravity storm drainage lines will be collected by means of a building foundation drain. The foundation drainage system will be provided at footings of the structural foundation in accordance with the Geologist report.
7. The foundation drainage system will discharge into a sump pit from which it will be pumped up such that the discharge can flow by gravity to the city storm drain system. The sump pit will be provided with two 100% redundant automatic sump pumps. System operation will be monitored by alarm panel provided with auxiliary contacts for remote annunciation in a continuously supervised location. Access to pumps and control panel will be maintained at 3'-0" minimum for servicing.
8. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWWA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.

C. Sanitary Design

1. The vents shall extend 6 inches above any roof not normally used. Vents terminating above roofs which are used for other than weather protection shall extend to a point 7 feet above the roof surface.
2. Building's over 10,000 square feet may have a sub-meter for sewage discharge. The sub-meter shall be configured to interface and exchange data with the District's existing software. Sub-meters shall include an Ethernet communications port or wireless communication capability or other networking capability. Sub-meters shall retain data for a period of no less than 12 months.
3. All the sanitary system including the above and underground horizontal piping will be sloped at 2% for sizes up to 3" and 1% for sizes 4" and larger.
4. There shall be cleanouts throughout the piping system as required by the Los Angeles City Plumbing Code.
5. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWWA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.
6. Waste generated below the elevation of city sewer mains will be drained by gravity to a sewage ejector pit.
7. The sewage ejector pumps will pump the waste up such that the discharge can flow by gravity to the city sewer main. The sewage ejector pit will be provided with two 100% redundant automatic pumps. The sewage ejector pit will be lined with air tight and will need to be properly vented. System operation will be monitored by alarm panel provided with auxiliary contacts for remote annunciation in a continuously supervised location. Access to pumps and control panel will be maintained at 3'-0" minimum for servicing.
8. Restrooms having two or more water closets or a combination of one water closet and one urinal shall be provided with floor drains.

9. Mechanical Rooms shall be provided with floor sinks and floor drains.
10. All equipment or condensate drains shall be discharged into a floor sink or another approved receptor.
11. There shall be a floor drain below all emergency showers. These floor drains shall have a trap primer.
12. Storage Closets, Hopper Rooms and Main Custodial Supply Areas shall have a floor drain and automatic trap primer.

D. Domestic Cold Water Design

1. A water meter and backflow preventer will typically be provided under Civil Engineer.
2. Every building shall have a water meter and the meter shall be integrated into the Building Management System.. The sub-meter shall be configured to interface and exchange data with the District's existing software. Sub-meters shall include an Ethernet communications port or wireless communication capability or other networking capability. Sub-meters shall retain data for a period of no less than 12 months.
3. If required, the available water pressure in the building will be reduced to the below the maximum code requirement of 80 PSI. The reduction in pressure will be by means of a pressure reducing station consisting of a line size pressure reducing valve and a parallel bypass. Both pressure reducing valves will be provided with strainers. The Pressure reducing station will be located outside the building in an easily accessible location.
4. As a minimum, each building shall be provided with one backflow preventer. The domestic water system shall be provided with reduced pressure backflow preventers. These backflow preventers shall be on a concrete pad with a lockable cage. The cage shall have a rounded top to reduce the likelihood of a student sitting on the top of the cage. The cage shall be of suitable construction to prevent damage due to students sitting on it.
5. The cold water system shall be thoroughly thought out to limit the quantity of backflow preventers feeding the building(s) as well as to limit the backflow preventers used inside the building. The intent is to keep to a minimum the quantity of backflow preventers used.
6. Hydraulic calculations shall be performed for each building. The hydraulic calculations shall include the pressure losses for the change in site elevation changes, site piping, meter losses, backflow pressure losses, building static, mixing valve losses, pressure reducing valve fall offs, and any other losses that may be applicable.
7. The domestic water piping shall be designed to a pressure loss of 3 psi per 100 feet and a maximum velocity of 6 feet per second unless the hydraulic calculation indicated a different pressure loss for the piping.
8. Domestic water piping shall not be oversized.
9. A common cold water line shall supply back-to-back fixtures.
10. The domestic water system shall be designed such that there will be 30 psi at the most remote flush valve fixture and 20 psi at the most remote fixture.

11. Hose bibbs shall be provided in Mechanical Rooms, in all public restrooms, by Mechanical Units on the roof, and as required by the Architect along the exterior of the building.
12. Combination emergency eyewash/shower stations shall be provided in accordance with ANSI Z358.1 in locations where there may be the possibility of having fluids discharged on to the skin or into the eyes.
13. All floor drain and floor sinks shall be provided with a trap primer.
14. Pressure differential trap primers or flush valve primers shall be utilized to maintain p-traps where there is a water header serving a flushvalve. The pressure differential trap primers shall activate at 3 psi differential.
15. Electronic trap primers shall be utilized to maintain p-traps where there are no flushvalve headers to connect.
16. All electronic and pressure differential type trap primers shall be provided with an isolation valve.
17. All trap primers shall be behind a lockable 12" by 12" access panel.
18. All water hammer arrestors shall be behind a lockable 12" by 12" access panel.
19. The only plumbing that shall be in or run over a Telecommunication Room, UPS , Battery Rooms, Electrical Room and Elevator/Escalator Machine Room will those which serve these rooms.
20. There shall be shut-off valves for each restroom, at the bottom of each riser, for each floor, prior to each piece of equipment and strategically placed throughout the domestic water system. All shut-off valve will be line size ball valves.
21. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWWA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.

E. Domestic Hot Water Design

1. Water temperature to plumbing fixtures will not exceed 120 degrees F. Only heaters with a minimum output of 84% thermal efficiency will be selected. Circulation pumps will be utilized to circulate the hot water throughout the building and back to the heaters if the fixtures are more than 20 feet from the water heater. The hot water equipment will be located in its own room or a Mechanical Room.
2. An aquastat and 7 day time clock located in NEMA rated control panel will be provided for a complete automatic operation of the system.
3. The domestic water piping shall be designed to a pressure loss of 3 psi per 100 feet and a maximum velocity of 4 feet per second unless the hydraulic calculation indicated a different pressure loss for the piping.
4. Master mixing valves shall not be used. Individual mixing valves will be provided at each fixture.
5. Domestic water piping shall not be oversized.
6. A common hot water line shall supply back-to-back fixtures.

7. The domestic water system shall be design such that there will be 20 psi at the most remote fixture.
8. All hot water piping shall be insulated over the entire length.
9. There shall be shut-off valves for each restroom, at the bottom of each riser, prior to each piece of equipment and strategically placed throughout the domestic water system. All shut-off valve will be line size ball valves.
10. There shall be shut-off valves for each restroom, prior to each restroom, at the bottom of each riser, prior to each piece of equipment and strategically placed throughout the domestic water system. All shut-off valve will be line size ball valves.
11. All hot water and return piping will be insulated with pre-formed jacketed fiberglass insulation to maintain set temperature and minimize temperature drop in uncirculated dead-end hot water lines.

F. Piping

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale and dirt, on inside and outside, before assembly.
3. Connect to equipment with flanges or unions.
4. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
5. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
6. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
7. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
8. Provide flanges or unions at all final connections to equipment and valves.
9. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
10. Unless otherwise indicated, install all piping, including shutoff valves and strainers, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
11. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
12. Provide dielectric connections between dissimilar metals.
13. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.

14. Slope water piping and arrange to drain at low points.
15. Seal pipes passing through exterior walls. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
16. Underground Piping:
 - a. Install buried water piping outside the building with at least 3 feet of cover.
 - b. Underground fire protection service piping shall have at least 3 feet of cover, or as recommended by NFPA 24, whichever is greater.
17. Sanitary and Storm Piping:
 - a. All sanitary and storm piping shall have at least 36" of cover when leaving the building.
18. Unless otherwise indicated on the drawings, all horizontal water and compressed air lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
19. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
20. Provide drip legs at low points and at the base of all risers in compressed air pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.
21. Main Custodial Supply Areas shall have 2 compressed air connections from a compressor with a minimum of 25 cfm at 90 psi, 10 Hp, electric driven motor and a 90 gallon receiver.
22. There shall be water faucets on the outside of the Main Custodial Room.
23. The Main Custodial Supply Room shall have a commercial washer and dryer. The washer and dryer shall be front loading with a 60 lbs. capacity.
24. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install compressed air and gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
25. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
26. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
27. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
28. Vent pipes through the roof shall be located a minimum of 10 feet from any air intake or exhaust opening on the roof.
29. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

30. Provide necessary connections at the start of individual sections of mains for adding chlorine.

G. Valves

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
3. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement.
4. Provide clearance for installation of insulation and access to valves and fittings.
5. Provide 12" by 12" access panels for concealed valves.
6. Install valve stems upright or horizontal, not inverted.

H. Deionized (DI) Water

1. The DI system shall consist of three basic components; a Reverse Osmosis Skid, RO/DI Water Post Treatment/Pump Skid and storage tank.
2. The Reverse Osmosis Skid shall consist of 5 micron prefilters, Sodium Bisulfate Chemical Feed System, Antiscalant Feed System, Booster Pump, RO Membrane vessels, adjustable flow controls, FRP Pressure Vessels with TFC membranes, required gauges and controls mounted on a powder coated frame.
3. The low pressure piping on the skid shall be Schedule 80 PVC and ½" poly tubing. The high pressure piping shall be Schedule 80 PVC and ½" poly tubing
4. The pump shall have a stainless steel body with a 200 psig pressure rating.
5. The RO/DI Water Post Treatment/Pump Skid shall consist of UV light(s), DI bottles, Mixed Bed Exchange Tank, Recirculation Loop Resistivity Monitoring, 1 Micron DI Filter(s), 0.2 Micron Sub-Filter(s), backpressure valve, Multistage DI Pump(s), required gauges and controls mounted on a powder coated frame.
6. The suction and discharge piping shall be Schedule 80 Polypropylene.
7. The tank shall be 100 gallons, constructed of Isophthalic Resin, dished bottom and annular head configuration
8. The tank shall be in a containment basin having a capacity equivalent to the tank volume.

I. Air Compressors

1. Install compressor units on concrete foundation with sole plates and vibration isolators as scheduled on the drawings. Level, grout, and bolt in place.
2. Install line size shutoff valve and check valve on compressor discharge.
3. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.
4. Place shutoff valve on water inlet to aftercooler. Pipe drain to floor drain.
5. Connect condensate drains to nearest floor sink.

6. Install valved bypass around air dryers. Factory insulate inlet and outlet connections.
7. Install drain valves at all low points of piping system.
8. Install take-offs from top of mains, with shutoff valves after take-offs. Install line size filter regulators at each take-off.
9. Install compressed air couplings, 3/8" female speed couplers, and pressure gauges where outlets are indicated.

J. Natural Gas Design

1. The system pressure will be selected by the Engineer based on the length of run and the quantity of gas required.
2. Building's over 10,000 square feet shall have a sub-meter for natural gas. The sub-meter shall be configured to interface and exchange data with the District's existing software. Sub-meters shall include an Ethernet communications port or wireless communication capability or other networking capability. Sub-meters shall retain data for a period of no less than 12 months.
3. If at all possible no gas piping shall be run below a building. If it is necessary to run the piping below the slab, a CPC code compliant double containment system shall be installed.
4. The gas line will include a service shut-off valve and seismic type gas valve to interrupt gas flow to equipment during seismic events. A separate manual shut-off valve will be provided upstream of the seismic valve for service when necessary.
5. Install No. 12 Insulated Type UF copper tracer wire, terminate above grade at each end of non-metallic gas pipe.
6. No metallic piping shall be used underground. Only Polyethylene piping shall be used underground.

K. Pipe Markers:

1. All pipe markers shall be compliant with ASME A13.1.
2. Pipes to be marked shall be labeled with the text as shown in the following table regardless of which method or material is used:

Pipe Service	Lettering Color	Background Color
CONDENSATE DRAIN	Black	Yellow
COMPRESSED AIR	Black	Yellow
DOMESTIC COLD WATER	White	Green
DOMESTIC HOT WATER - 115°F	Black	Yellow
DOMESTIC HOT WATER - 140°F	Black	Yellow
DOMESTIC HOT WATER CIRCULATING - 115°F	Black	Yellow
DOMESTIC HOT WATER CIRCULATING - 140°F	Black	Yellow
SANITARY SEWER	Black	Yellow
VENT	Black	Yellow
STORM SEWER (PRIMARY AND SECONDARY)	White	Green
NATURAL GAS	Black	Yellow
TEMPERED WATER	Black	Yellow
TEMPERED WATER RETURN	Black	Yellow
NON-POTABLE WATER	Black	Yellow
DEIONIZED WATER	White	Green
DISTILLED WATER	White	Green
RO WATER	White	Green
FUEL OIL SUPPLY	Black	Yellow
FUEL OIL RETURN	Black	Yellow
Tracer Wire - Water Pipe Lines	---	Blue
Tracer Wire - Natural Gas Pipe Lines	---	Yellow
Tracer Wire - All other buried types	---	Green

3. Secure all adhesive markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
4. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.
5. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

L. Tracer Wire

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tracer wire shall be continuous between boxes and shall be tested for continuity.
6. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion.
Wire nuts shall not be used.
7. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

M. Fixtures

1. All restrooms shall be ADA compliant.
2. All fixtures shall be white.
3. Urinals shall be 17" minimum width with extended side.
4. All fixtures shall be easy to install and replace by using standard/none-proprietary tools.
5. All surfaces and finishes of the fixtures shall withstand commercial usage and harsh chemical treatment during cleaning and maintenance yet vandal resistant.
6. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
7. Seal fixtures to wall and floor surfaces with sealant.
8. Solidly attach water closets to the wall.
9. No waterless urinals shall be used.
10. For ADA accessible water closets, install flush valve with handle to wide side of stall.
11. Provide gray water to water closets and Urinals where it is available.
12. Fixtures shall not have filters or cartridges which require regular maintenance or replacement.
13. Provide access panels to all plumbing devices in the wall.
14. Hopper rooms shall have a corner floor type mop sink with hot and cold water, mop hanger, 36" hose with wall hanger, vacuum breaker on the faucet.
15. Main Custodial Supply Area shall have a 41-inch high stainless steel utility sink, wall mounted faucet with built in backflow preventer and level handles.

N. Water Hammer Arresters:

1. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
 2. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.
- O. Cleanouts:
1. Provide cleanouts at bases of all sanitary and storm risers.
 2. Extend cleanouts to the floor above with long sweep elbows.
 3. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
 4. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.
 5. Cleanouts shall be so located that they are in open spaces or have easy access.
- P. Floor Drains and Sinks:
1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
 2. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
- Q. Backflow Preventer:
1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
 2. Install unit between 12" and 60" above finish floor.
- R. Balancing Valves:
1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

SECTION 22 05 29

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices
- D. MSS SP-127 – Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
- E. California Building Code (CBC)
- F. California Division of State Architect (DSA)f

PART 2 PRODUCTS

2.01 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:
Hanger Rod Diameter

Pipe Size	Column #1	Column #2
2" and smaller	3/8"	3/8"
2-1/2" through 3-5/8"	1/2"	1/2"
4" and 5"	5/8"	1/2"
6"	3/4"	5/8"
8" through 12"	7/8"	3/4"
14"	1"	7/8"
16" and 18"	1"	N/A
20" and 24"	1-1/4"	N/A

Column #1: Steel, cast iron, and glass pipe.

Column #2: Copper and plastic pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

2.02 PIPE AND STRUCTURAL SUPPORTS

A. General:

- 1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
- 2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing.
 - a. Insulation Couplings:
 - 1) Insulation Coupling: Molded thermoplastic, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - 2) Horizontal Strut Mounted Insulated Pipe:
 - (a) Acceptable Manufacturers: Klo-Shure.
 - 3) Vertical:
 - (a) Acceptable Manufacturers: Klo-Shure Titan.
- 3. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitor's closets, shall use band hangers for copper tubing. Support shall include plastic pipe insert. Use threaded rod. There are to be electro-galvanized or have a more corrosion resistant coating. Wall anchors are to have corrosion resistant threaded rod. Acceptable Manufacturers: Erico/M-Co, B-Line, Anvil or Nibco/Tolco.

B. Vertical Supports:

- 1. Support and laterally brace vertical pipes at every floor level in a multi-story structure, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations. Acceptable Manufacturer: Copper/B-Line, Erico or Nibco/Tolco.
- 2. Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts. Acceptable Manufacturers: Mason.

C. Hangers and Clamps:

- 1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
- 2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.

3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. As an alternative to separate pipe insulation insert and saddle, properly sized integral rigid insulation sections may be used. Acceptable Manufacturers: Copper/B-Line, Pipe Shields or Erico.
5. Unless otherwise indicated, hangers shall be as follows:
 - a. Clevis Type:
Service: Bare Metal Pipe
Rigid Plastic Pipe
Insulated Cold Pipe
Insulated Hot Pipe - 3 inches & Smaller

Acceptable Manufacturers: Anvil, Copper/B-Line, Erico or Nibco/Tolco.

- b. Adjustable Swivel Ring Type:
Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Manufacturers: Anvil, Copper/B-Line, Erico or Nibco/Tolco.

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
 - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type:
Service: Bare Metal Pipe
Rigid Plastic Pipe
Insulated Cold Pipe
Insulated Hot Pipe - 3 inches and smaller
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
 - 3) Acceptable Manufacturers: Unistrut, Cooper/B-Line or Nibco/Tolco.

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Steel Structure Clamps
 - 1) C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists):

- 2) Acceptable Manufacturers: Anvil, Cooper/B-Line, Erico or Nibco/Tolco.
- 3) Scissor Type Beam Clamps (For use with bar-joists and wide flange):
- 4) Acceptable Manufacturers: Anvil, Cooper/B-Line, Erico or Nibco/Tolco.

b. Concrete

- 1) Concrete Inserts, Single Rod Galvanized:
- 2) Acceptable Manufacturers: Anvil, Cooper/B-Line, Erico or Nibco/Tolco.
- 3) Concrete Inserts, Continuous Strip Galvanized:
- 4) Acceptable Manufacturers: Unistrut, Cooper/B-Line or Erico.
- 5) Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
- 6) Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

c. Steel Structure Welding:

- 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.03 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports for plumbing equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Concrete bases shall be a minimum of 4 inches thick and shall extend a minimum of 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.

C. Roof Pipe Supports:

1. Provide pre-fabricated roof pipe supports for all piping installed on the roof.
2. Support shall guide and align pipe while permitting longitudinal expansion.
3. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

4. Support shall be UV, corrosion and freeze/thaw resistant.
5. Support shall include orange paint, reflective safety orange accents or similar markings for increased visibility.
6. The strut system shall have galvanized aluminum, 302 stainless steel, 316 stainless steel, PVC coated, powder coated or zinc trivalent chromium finish.
7. Acceptable Manufacturers: Anvil , Cooper B-Line, Erico or Miro Industries.

D. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Support heavy equipment from concrete floors or hang from ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

E. Grout:

1. Grout shall be non-shrinking premixed, unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.04 MATERIALS FOR SEISMIC BRACING

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.05 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS FOR SEISMIC BRACING

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings and matched to the type and size of anchor bolts and studs used.

- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings and matched to the type and size of attachment devices used.

2.06 SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 - 1. Materials for Channel: ASTM A 1011, GR 33.
 - 2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
 - 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 - 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

2.07 ROOF PENETRATIONS

- A. Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped pipe flashings and stainless-steel clamps equal to Portals Plus Pipe Boots. Material shall match roofing membrane.
- B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.08 SLEEVES AND LINTELS

- A. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- B. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- C. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- D. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- E. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- G. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- H. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

I. Wall Seals ("Link-Seals"):

1. Pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120°F, sleeves may be thermoplastic with integral water seal and textured surface.
3. Sleeves shall be at least 2 pipe sizes larger than the pipes.
4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.

5. Sealing element shall be as follows:

Service	Element Material	Temperature Range
Standard (Stainless)	EPDM	-40°F to 250°F
High/Low Temperature	Silicone	-67°F to 400°F
Fire Seals (1 hour)	Silicone	-67°F to 400°F
Fire Seals (3 hours)	Silicone	-67°F to 400°F
Oil Resistant/Stainless	Nitrile	-40°F to 210°F

6. Acceptable Manufacturers: Thunderline "Link-Seals", O-Z/Gedney Company, Calpico, Inc., Innerlynx, or Metraflex (cold service only).

2.09 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.10 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.11 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.12 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

END OF SECTION

SECTION 22 05 48

VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SUMMARY

- A. All plumbing piping and equipment as noted on the equipment schedules or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.
- B. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- C. All plumbing piping and equipment as noted on the equipment schedules, in the specification or as required by code shall be designed to resist seismic forces. Refer to Section 220549- Seismic Restraint for Plumbing Piping and Equipment.
- D. This Section includes the following:
 - 1. Vibration Isolation pads.
 - 2. Vibration Isolation mounts.
 - 3. Restrained uni-directional seismic isolation snubber mounts.
 - 4. Spring isolators.
 - 5. Housed seismic spring vibration mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Air-mounting system.
 - 12. Seismic snubbers.
 - 13. Seismic Restraining braces and cable systems for equipment, piping, and ductwork.
 - 14. Vibration isolation equipment bases.
 - 15. Flexible piping connectors
 - 16. Flexible ductwork connectors

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Plumbing Materials and Methods
- B. Section 220549: Seismic Restraint for Plumbing Piping and Equipment

1.04 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction
- B. IBC: International Building Code with State Amendments.
- C. ICC-ES: ICC-Evaluation Service.

1.05 CODES AND STANDARDS

- A. Provide components conforming to the load requirements of the latest addition of the local building code and the following:
 - 1. International Building Code with AHJ Amendments
 - 2. American Society of Civil Engineers (ASCE):
 - a. ASCE 7 (Latest Edition): Minimum Design Loads for Buildings and Other Structures
 - 3. The Manufacturers Standardization Society (MSS):
 - a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
 - b. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
 - c. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices
 - d. MSS SP-127: Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
 - 4. Mason West Inc. Seismic Restraint Guidelines 2014 Edition
 - a. For all suspended piping.

1.06 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Refer to Section 220549 Seismic Restraint for Plumbing Piping and Equipment for seismic specific requirements.
 - 2. Vibration isolators must be rated for the seismic loading associated with the system and forces calculated for this building location. Seismic forces for new installations are determined per ASCE 7. Refer to Structural Design for seismic factors and design criteria. Select and submit appropriate values for each piece of equipment and sub-system and material type for the project, and base the seismic calculations on these values.
 - 3. Coordinate all seismic and load requirements with the registered professional Structural Engineer.
- B. Component Importance Factor:

1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
2. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category; or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
 - a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.
 - b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

1.07 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Building Structural Limits: The design of supports and restraints shall not exceed the building structure allowable point loads. Coordinate all work with the registered professional Structural Engineer.
- D. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17 of the IBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per IBC Section 1705 all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.

1.08 SUBMITTALS

- A. Product Data shall include the following:
 1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
 2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
 3. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 4. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

- B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 2. Provide all details of suspension and support for ceiling hung equipment.
 3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint the locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
- C. Manufacturer Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.
- D. Coordination Drawings: Show coordination and plan locations of seismic bracing for HVAC piping, ductwork, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Structural Engineer.
- F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.
- G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.09 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Division 01 and Section 220500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:

1. Standard paint applied to factory-assembled equipment before shipping.
2. Powder coating on springs and housings.
3. All hardware shall be galvanized or powder coated.
4. Hot-dip galvanized or powder coating of metal components for exterior use.
5. Baked enamel or powder coat for metal components for interior use.

B. Glumac Device Key Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with plumbing equipment found on this project. The tag designation of preferred devices is as follows:

Glumac Isolator Tag	Description
P-1	Vibration isolation waffle pad
P-2	Double deflection neoprene mount
P-3	Uni-directional restrained neoprene snubber mount
P-4	Interlocking uni-directional snubber
S-1	Open spring vibration isolator
S-2	Steel housed seismic spring vibration isolator
S-3	Bellows air spring isolator
S-4	Restrained air spring isolator
B-1	Integral equipment and motor base
B-2	Integral equipment and motor base
B-3	Concrete filled steel inertia base
H-1	Spring and rubber in shear vibration isolation hanger
G-1	All-directional pipe anchor
G-2	Vertical pipe guide
G-3	Horizontal thrust restraint
SB-1	Sway bracing
F-1	Kevlar/rubber spherical type flexible piping coupling
F-2	Stainless hose flexible piping coupling
F-3	Flexible expansion joints

2.02 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Kinetics Noise Control.
 5. Vibration Eliminator Co., Inc.

6. Vibration Isolation.
 7. Vibration Mountings & Controls, Inc
 8. Vibro-Acoustics, Inc
 9. Vibrex
- B. P-1 Style: Neoprene pads shall consist of a 3/4" (19 mm) thick neoprene pad molded in square waffle modules, a minimum 1/4" (6 mm) thick steel load distribution plate and 3/4" (19 mm) hole with a neoprene anchor bolt bushing with a flat washer face. Pads may be single or multiple layers as required for leveling. Pads shall be Mason #MBSW Series or equal.
- C. P-2 Style: Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall be Mason #BR Series or equal.
- D. P-3 Style: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6 mm) thick. A minimum air gap of 1/8" (3 mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. No sharp edges such as bolt threads may come in contact with the neoprene bushing. Snubber end caps shall be removable to allow inspection of internal clearances. Snubber shall be Mason #Z-1225 Series.
- E. P-4 Style: All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19 mm) thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3 mm) nor more than 1/4" (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9 mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12 mm) deflection in the x, y and z planes. Snubbers shall be Mason #Z-1011 Series.
- F. S-1 Style: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Two base plate holes for attachment to support surface. Isolators shall be Mason #SLFH Series or equal.

- G. S-2 Style: Restrained spring mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the spring and the mounting base plate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8" (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall be Mason #SLR Series or #SLRS Series for steel/wood connections and Mason #SLREBP Series or #SLRSEBP Series or #SSLFH Series for concrete connections.
- H. S-3 Style: Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Air springs shall be Mason #MT and leveling valves Mason #LV.
- I. S-4 Style: Restrained mountings shall include multiple bellow air springs manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8" (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have test reports or calculations certifying the maximum allowable horizontal and vertical load ratings. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Mountings shall be Mason #SLR-MT for steel connections and Mason #SLREBP for concrete connections and leveling valves Mason #LV.

2.03 VIBRATION ISOLATION STEEL EQUIPMENT BASES

- A. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:
1. Mason, basis of selection or equal by
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Vibration Eliminator Co., Inc.
 7. Vibration Isolation.
 8. Vibration Mountings & Controls, Inc
 9. Vibro-Acoustics, Inc.

- B. B-1 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded structural steel angle or channel members. Base shall be Mason #MSL Series.
- C. B-2 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" (25 mm) clearance below the base. Base shall be Mason #WFSL Series.
- D. B-3 Style: Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows and shall be 6" deep for pumps thru 75 HP and 10" deep for pumps 100 HP thru 250HP. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Base shall be Mason #BMK Series or #KSL Series.

2.04 SPRING HANGERS

- A. H-1 Style: Spring hangers shall consist of rigid steel frames containing minimum 1-1/4" (32 mm) thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. A seismic rebound washer made of steel and surrounding neoprene shall be provided. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Hangers shall be Mason #RW30N Series.

2.05 PIPE GUIDES AND SUPPORTS

- A. G-1 Style: All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (12 mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason #ADA Series.
- B. G-2 Style: Vertical sliding pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (20 mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of 1-5/8" (41 mm) upwards or downwards motion, or to meet location requirements. Pipe guides shall be Mason #VSG Series.

- C. G-3 Style: Horizontal thrust restraints shall consist of a spring element seated in a steel washer reinforced neoprene cup at the bottom, in series with a molded neoprene element. Steel springs shall be free standing and laterally stable. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6 mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be Mason #WBI Series or #WBD Series.

2.06 SWAY BRACING

- A. SB-1 Style: Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles or struts. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of two (2). Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Do not mix cable and steel braces to brace the same system or equipment. Brace assemblies and rod clamps shall have an Anchorage Preapproval "OPM" Number from HCAI in the State of California verifying the maximum certified load ratings. Cable brace assemblies shall be Mason #SCB Series or #SCBH Series, steel brace assemblies shall be Mason #SSB Series, #SSBS Series or #SHB Series, and rod clamps shall be Mason #SRC Series or #UCC Series.

2.07 FLEXIBLE PIPING CONNECTORS

- A. F-1 Style: Flexible spherical expansion joints for pump connections. Shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Manufacturer shall provide pre-stretching charts for expansion joints when used in conjunction with isolated equipment. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be Mason #SAFEFLEX SFDEJ Series, #SAFEFLEX SFEJ Series, #SAFEFLEX SFDCR Series or #SAFEFLEX SFU Series and Control Rods Mason #CR.

- B. F-2 Style: Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75 mm) and larger shall be flanged. Smaller sizes shall have male threaded nipples or copper sweat ends. Hoses must have sufficient length, minimum 12" (300 mm) long, to accept 1/2" (12 mm) intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Mason #FFL Flanged Series, #CPSB Copper Sweat Series or #CSAMN Threaded Series
- C. F-3 Style: Flexible Vee or U-bend braided hose across building or expansion joints. Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose Vee assemblies rated for $\pm 4"$ (100mm) seismic motion in all planes. Should the application include $\pm 6"$ (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial. Vees shall have a minimum burst pressure of four times their rated pressure. Vees in steel lines shall have stainless hose and braid. Copper lines, bronze hose and braid. Guiding and anchoring shall be as recommended by the manufacturer. 60° Vees shall be Mason #VFL flanged braided steel Series, #VMN Threaded Braided Stainless Steel Series or #VCPSB Copper Sweat Series.

2.08 BRACING DEVICES FOR EQUIPMENT, PIPING, AND DUCTWORK.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation
 - 3. Cooper B-Line, Inc.
 - 4. Hilti, Inc.
 - 5. Kinetics Noise Control
 - 6. Loos & Co.
 - 7. Mason Industries
 - 8. Tolco Incorporated
 - 9. Unistrut
 - 10. ISAT, Inc
 - 11. Vibro-Acoustics, Inc.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least two (2) times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4" (6 mm) thick resilient cushion.

- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- E. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.
- F. Bushings for Floor-Mounted Equipment Anchorage: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.
- J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 EXECUTION

3.01 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

- A. The following Tables provide schedules for vibration devices required for isolation of plumbing equipment provided on the project. Refer to Part 2 above for device specifications.

B. Pumps – Equipment Isolation

TABLE 1: EQUIPMENT ISOLATION SCHEDULE –										
PUMPS										
		LOCATION								
EQUIPMENT		CRITICAL ROOF OR FLOOR			UPPER STORY			ON GRADE		
		(35' - 50' SPAN)			(20' - 35' SPAN)					
		ISOLATOR	MINIMUM	BASE	ISOLATOR	MINIMUM	BASE	ISOLATOR	MINIMUM	BASE
		TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE
			(IN)			(IN)			(IN)	
PUMPS										
Base and Close Coupled Floor Mounted										
Up to 5 HP		S-2/S-1	0.75	B-2	S-2/S-1	0.75	B-1	S-2/S-1	0.4	B-1
7-1/2 HP & Over		S-2/S-1	1.5	B-2	S-2/S-1	1.5	B-2	S-2/S-1	0.75	B-2
Vertical Split Case Floor Mounted										
Up to 5 HP		P-1	0.15	NA	P-1	0.15	NA	P-1	0.15	NA
7-1/2 HP & Over		S-2/S-1	1.5	B-2	S-2/S-1	1.5	B-2	P-1	0.15	NA
Suspended Inline		H-1	1.75	NA	H-1	1.75	NA	H-1	1.0	NA

Notes:

- (1) Alternate: Factory installed by equipment manufacturer.
- (2) Provide full perimeter steel welded frame below equipment
- (3) Provide support per manufacturer's recommendation
- (4) Provide F-1 flexible connector for all high horsepower pumps, F-2 connector for fractional horsepower pumps.

C. Miscellaneous Equipment Isolation

TABLE 2: EQUIPMENT ISOLATION SCHEDULE –										
MISCELLANEOUS EQUIPMENT										
		LOCATION								
EQUIPMENT		CRITICAL			UPPER STORY			ON GRADE		
		(35' - 50' SPAN)			(20' - 35' SPAN)					
		ISOLATOR	MINIMUM	BASE	ISOLATOR	MINIMUM	BASE	ISOLATOR	MINIMUM	BASE
		TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE
			(IN)			(IN)			(IN)	
		TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE	TYPE	DEFLECTION	TYPE
BOILER (PACKAGE TYPE)										
All Sizes		P-1	0.15	(3)	P-1	0.15	(3)	P-1	0.15	(3)
ENGINE DRIVEN GENERATORS										
Up to 60 HP		S-2	2.5	B-2	S-2	1.5	B-2	S-2	0.75	NA
75 HP & Over		S-2	3.5	B-2	S-2	2.5	B-2	S-2	0.75	NA
AIR COMPRESSORS AND VACUUM PUMPS										
Tank Type (Horizontal Tank)		S-2	2.5	B-2	S-1	1.5	B-2	S-1	0.75	NA
Tank Type (Vertical Tank)		S-1	2.5	B-2	S-2/S-1	1.5	B-2	S-1	0.75	NA

Notes:

- (1) Alternate: Factory installed by equipment manufacturer.
- (2) Provide full perimeter steel welded frame below equipment
- (3) Provide support per manufacturer's recommendation
- (4) For pipe connections to HVAC units provide F-2 pipe and F-3 duct connectors.

3.02 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.04 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
- C. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
- D. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- E. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

- F. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner's Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- H. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- I. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- J. Flexible Pipe Connectors: Install on equipment side of shutoff valves.
- K. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.
- L. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction. Provide required submittals for components.
- M. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12m) and longitudinal supports a maximum of 80 feet (24m).
 - 3. Brace a change of direction longer than 12 feet (3.7m).
- N. Install cables so they do not bend across edges of adjacent equipment or building structure.
- O. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction, providing required submittals for component.
- P. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.
- Q. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- R. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- S. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.05 VIBRATION ISOLATION OF PIPING

- A. Horizontal Piping: The first three pipe supports from vibration isolated equipment must be vibration isolated. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators under the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers, or equal. Floor supported piping shall rest on Mason Type SLR isolators, or equal. Refer to contract drawings for additional vibration isolation requirements for piping. Where piping connects to plumbing equipment install Mason Type SFDEJ or SFU expansion joints or Mason Type FFL stainless hoses if Type SFDEJ or SFU is not suitable for the service.
- B. Riser isolation: Risers that experience excessive thermal expansion shall be suspended from Mason Type 30N spring hangers or supported by Mason Type SLF(H) spring mountings, anchored with Mason Type ADA(H) anchors, and guided with Mason Type VSG(H) sliding guides. Horizontal pipe runs and branches shall be supported on Mason Type 30N spring hangers for the first three supports from the risers. Steel springs shall be selected to provide a minimum of 0.75" static deflection except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.07 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.

- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 22 05 53

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. UL83 - Thermoplastic-insulated Wires and Cables.
- C. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>OD of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

- H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
- I. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.
- J. Acceptable Manufacturers: 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.
- K. Tracer Wire:
 - 1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
 - 2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
 - 3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.
 - 4. Tracer wire shall be installed on top of all non-metallic pipes.

END OF SECTION

SECTION 22 05 76

CLEANOUTS, STORM AND SANITARY

PART 1 GENERAL

PART 2 PRODUCTS

2.01 CLEANOUTS

- A. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- B. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.
- C. Exterior Surfaced Areas: [Round] [Square] cast nickel bronze access frame and non-skid cover.
- D. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- E. Interior Finished Floor Areas: Lacquered] cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and [round] [square] depressed cover with gasket to accept floor finish in finished floor areas.
- F. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.
- G. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
- H. Acceptable Manufacturers: WATTS, MIFAB, J.R. Smith or Zurn.

END OF SECTION

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SECTION 22 07 00

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- B. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- C. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation.
- D. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.
- E. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation.
- F. ASTM E84 - Surface Burning Characteristics of Building Materials.
- G. NFPA 255 - Surface Burning Characteristics of Building Materials.
- H. UL 723 - Surface Burning Characteristics of Building Materials.

PART 2 PRODUCTS

2.01 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All purpose, white Kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- B. Type B: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
- C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.35 maximum 'K' value at 75°F; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose white Kraft jacket for above grade installations.
- D. Type D: Hydrous Calcium Silicate; ASTM C533; rigid molded pipe insulation; asbestos free; 0.40 'K' value at 300°F; 1200°F maximum service temperature; 16 gauge stainless steel tie wires on maximum 12" centers.
- E. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; moisture resistant; suitable for -297°F to +300°F.

2.02 VAPOR BARRIER JACKETS

- A. Kraft reinforced foil vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.03 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
- B. Stainless Steel Jackets: ASTM C1767. Type [304] [316] stainless steel; 0.010" thick (thicker where required by ASTM C1729); smooth finish with Z edge seams and stainless steel bands for outdoor use.
- C. Plastic Jackets and Fitting Covers: High impact, glossy white, [0.020"] [0.030"] thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. 25/50 maximum flame spread/smoke developed.

END OF SECTION

SECTION 22 11 00

PLUMBING PIPING, VALVES, AND SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

- A. NSF - National Sanitation Foundation
- B. American National Standards Institute (ANSI)/American Water Works Association (AWWA):
 - 1. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.
 - 2. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 3. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - 4. ANSI/AWWA C153 – Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.
- C. American Society of Mechanical Engineers (ASME):
 - 1. ANSI/ASME A112.3.1 – Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above and Below Ground.
 - 2. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
 - 3. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
 - 4. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
 - 2. ASTM B88 - Seamless Copper Water Tube.
 - 3. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes. ASTM A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.
 - 4. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.
 - 5. ASTM B306 - Copper Drainage Tube (DWV).
 - 6. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - 7. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - 8. ANSI/ASTM B32 - Solder Metal.
 - 9. ASTM E-84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. FM CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- F. 1680 - Couplings Used in Hubless Cast Iron Systems.
- G. UL 723 - Standard for Test of Surface Burning Characteristics or Building Materials.

- H. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers; American Society of Sanitary Engineering; 1.
- I. ASSE 1015 – Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.

PART 2 PRODUCTS

2.01 COLD, HOT, AND TEMPERED WATER PIPING - POTABLE AND NON-POTABLE (ABOVE GROUND)

- A. Design Pressure: 175 psi.
Maximum Design Temperature: 200°F.
- B. Piping - All Sizes:
 - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
 - 2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
 - 3. Fittings: Wrought copper solder joint, ANSI B16.22.
- C. Piping - 4" and Under:
 - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
 - 2. Joints: Mechanical press connection.
 - 3. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
 - 4. Acceptable Manufacturers: Viega ProPress, Elkhart Xpress, Nibco Press System Fittings and Valves, Mueller Streamline PRS.

2.02 COLD, HOT, AND TEMPERED WATER PIPING - POTABLE AND NON-POTABLE (UNDERGROUND)

- A. Design Pressure: 150 psi.
Maximum Design Temperature: 200°F.
- B. Piping - All Sizes:
 - 1. Tubing: Type K annealed copper tube, ASTM B88.
 - 2. Joints: Brazed Alloy, BCuP-5, AWS A5.8.
 - 3. Fittings: Wrought copper solder joint, ANSI B16.22.
- C. Piping - 4" and Under:
 - 1. Tubing: Type K annealed copper tube, ASTM B88.
 - 2. Joints: Mechanical press connection.
 - 3. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
 - 4. Acceptable Manufacturers: Viega ProPress, Elkhart Xpress, Nibco Press System Fittings and Valves, Mueller Streamline PRS.

2.03 SERVICE WATER PIPING - POTABLE

- A. Design Pressure: 200 psi.

Maximum Design Temperature: 150°F.

B. Piping:

1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
2. Fittings: Ductile iron, ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, push-on joints or mechanical joints.
3. Joint: Push-on joint with rubber gasket, ANSI/AWWA C111/A21.11.
4. Joint: Mechanical joint with glands and gaskets and steel bolts. ANSI/AWWAC111/A21.11.

C. Piping - 2" and Under:

1. Tubing: Type K soft annealed copper tube, ASTM B88.
2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
3. Fittings: Wrought copper solder joint, ANSI B16.22.

D. Valve Box/Curb Box:

1. 2" and under, extension type curb box with arch pattern base and sufficient length to allow top to terminate flush with finished grade. Cast iron lid with integrally cast brass bushing and marked "water" in integrally cast raised letters. Furnished with valve operating wrench of sufficient length to extend 3' above finished grade when engaged with valve. Construction of curb box shall meet all local codes and requirements. Acceptable Manufacturers: Mueller, A.Y. McDonald, Tyler Pipe.
2. 3" through 12", extension type valve box with flat base, 5-1/4" shaft and sufficient length to allow top to terminate flush with finished grade. Cast iron lid marked "water" in integrally cast letters. Furnished with valve operating wrench of sufficient length to extend 3' above finished grade when engaged with valve. Construction of curb box shall meet all local codes and requirements.
3. Acceptable Manufacturers: Tyler Pipe.

2.04 DEMINERALIZED AND DISTILLED WATER PIPING

A. Design Pressure: 50 psi.

Maximum Design Temperature: 120°F

B. Piping:

1. Pipe: Schedule 40, rigid, unplasticized PVC, normal impact Type I, plain ends.
2. Joints: Solvent-weld socket type with solvent as recommended by manufacturer.
3. Fittings: Unplasticized PVC, normal impact Type I, solvent-weld socket type ends for Schedule 40 pipe. For connections to equipment, outlets and valves requiring screwed connections, use solvent socket to screwed joint PVC adapters or unions.
4. Special Requirements: Schedule 40 PVC pipe.

C. Shutoff/Throttling Valves:

1. 2" and under, 125 psi at 95°F, 35 psi at 140°F, socket weld, PVC, true union ball valve with PTFE ball seats, EPDM O-ring seals. Acceptable Manufacturers: Georg Fischer, Asahi Omni, Nibco.
2. 2-1/2" to 6", 80 psi at 100°F, 25 psi at 140°F, socket weld, PVC, true union ball valve with PTFE ball seats, EPDM O-ring seals. Acceptable Manufacturers: Georg Fischer, Asahi Omni, Nibco.
3. 2" and under, 125# CWP @ 75°F, socket weld, normal impact PVC, Teflon faced diaphragm. Acceptable Manufacturers: Cabot Corp, Nibco/Chemtrol.

D. Check Valves:

1. All sizes, 125# CWP @ 75°F, socket weld, normal impact PVC, ball type. Cabot Corp, Nibco/Chemtrol.

2.05 DEIONIZED (DI) AND REVERSE OSMOSIS (RO) WATER PIPING

A. Design Pressure: 150 psi at 70°F

B. Piping: Ducted Returns

1. Pipe: Schedule 80 polypropylene without plasticizers or pigments, ASTM D-1785.
2. Joints: Fused type.
3. Fittings: Polypropylene socket fused or flanged fittings, ASTM D-4101.
4. Products: All manufacturers must have approval to furnish this system. Purity test data and fitting samples are required for evaluation of equivalency.

C. Acceptable products are as follows: Acceptable Manufacturers: Georg Fischer - PPRO-Seal, Enfield, Nibco/Chemtrol, Orion pure water piping.

D. Piping: Non-Ducted Returns

1. Pipe: Schedule 80 CPVC without plasticizers or pigments, ASTM D-1785.
2. Joints: Solvent type.
3. Fittings: CPVC socket type, ASTM D-4101.
4. Products: All manufacturers must have approval to furnish this system. Purity test data and fitting samples are required for evaluation of equivalency.

E. Acceptable Manufacturers: Corzan.

F. Shutoff and Throttling Valves:

1. Ball Valves:
 - a. 2" and under, 150 psi at 70°F, true union type, polypropylene or PVDF body and ball, PTFE or Viton seats and "O" rings. Acceptable Manufacturers: Sloun, ASAHI, Georg Fischer Plastics, Chemtrol.
 - b. 3" and 4", 150 psi at 73°F, flanged, virgin polypropylene or PVDF body and ball, PTFE seats and "O" rings. Acceptable Manufacturers: ASAHI, Chemtrol.

G. Check Valves:

1. PVDF or natural polypropylene with PTFE or Viton seats, flanged or true union ends, 75 psi at 140°F. Acceptable Manufacturers: ASahi (swing check with PVDF or PTFE coated SS hinge) or Enfield (ball type mounted in vertical pipe with upward flow), Nibco/Chemtrol.

2.06 COLD, HOT, AND TEMPERED WATER VALVES - POTABLE AND NON-POTABLE

A. Shutoff Valves:

1. For pipe systems where, mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Butterfly Valves:
 - a. 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line, Keystone, Watts, Stockham, Nibco, Milwaukee, Hammond.
 - b. 8" thru 12", 175# CWP, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line, Keystone, Watts, Stockham, Nibco, Milwaukee, Hammond.
 - c. Mechanically coupled grooved end valves are acceptable if they have the features listed above. Victaulic, Nibco.
3. Ball Valves:
 - a. 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo, Stockham, Milwaukee, Watts, Nibco, National Utilities Co., RUB.

NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

B. Throttling/Shutoff Valves:

1. For pipe systems where, mechanical press connections are allowed, throttling valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Globe Valves:

- a. 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Crane, Stockham, Walworth, Milwaukee, Hammond, Watts, Nibco.
- b. 2-1/2" thru 10", 125# steam @ 353°F, 200# CWP @ 150°F, flanged, iron body, bronze mounted. Crane, Hammond, Stockham, Walworth, Milwaukee, Watts, Nibco.

C. Check Valves:

1. For pipe systems where, mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane, Hammond, Stockham, Walworth, Milwaukee, Watts, Nibco.
3. 2-1/2" thru 12", 200# CWP, double disc wafer type, bronze or iron body, bronze trim, metal-to-metal or Viton seat, 316 SS shaft, Inconel 600 spring. Mission Duo Chek (with Inconel springs), Mueller Steam Specialty Co., Stockham, Nibco.

D. Strainers:

1. For pipe systems where, mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong, Metraflex, Mueller Steam Specialty Co., Sarco, Watts.
3. 2-1/2" thru 8", bronze body, flanged ends, flanged cover, 150# steam, 225# CWP. Mueller Steam Specialty Co.

2.07 SANITARY, VENT, AND STORM DRAINAGE (ABOVE GROUND)

A. Piping:

1. Pipe and Fittings: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF Certified, CISPI Trademark.
2. Joints: Compression gasket, ASTM C564.
3. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
4. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
5. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

2.08 SANITARY, VENT, AND STORM DRAINAGE (BELOW GROUND - INSIDE BUILDING)

A. Piping - All Sizes:

1. Pipe and Fittings: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF certified, CISPI trademark.
2. Joints: Compression gasket, ASTM C564.

3. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
4. Joints: Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
5. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

2.09 GREASE AND VENT SANITARY DRAINAGE (ABOVE AND BELOW GROUND)

A. Piping – 2” through 8”:

1. Pipe: Stainless Steel Type 316L, ASME A112.3.1
2. Fittings: Stainless Steel Type 316L, ASME A112.3.1, push-on joints.
3. Joints: Push-on joint with integral rubber gaskets suitable for use with greasy waste typical for kitchen grease sanitary applications.
4. Adapters: Transition from stainless steel pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C564, 300 Series stainless steel shield, clamp and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
5. Acceptable Manufacturers: Blucher, Watts, Josam, or approved equivalent.

B. Piping - 1-1/2" through 15":

1. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, epoxy paint corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

2.10 SANITARY AND STORM - PUMPED (BELOW GROUND - OUTSIDE OF BUILDING)

A. Piping - All Sizes:

1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
2. Fittings: Ductile iron, ANSI/AWWA C110/A21.10, or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, long radius, push-on joints.
3. Joint: Push-on joint with rubber gasket, ANSI/AWWA C111/A21.11.

B. Piping - All Sizes:

1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.

2. Fittings: Ductile iron, ANSI/AWWA C110/A21.10, or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar line per ANSI/AWWA C104/A21.4, long radius, mechanical joints.
3. Joint: Mechanical joint with glands and gaskets and steel bolts, ANSI/AWWA C111/A21.11.

2.11 SANITARY AND STORM - PUMPED (BELOW GROUND - INSIDE BUILDING)

A. Piping - All Sizes:

1. Tubing: Type K annealed copper tube, ASTM B88.
2. Joints: Brazed Alloy, BCuP-5, AWS A5.8.
3. Fittings: Long Radius Style, Wrought copper solder joint, ANSI B16.22.

2.12 SANITARY AND STORM – PUMPED (ABOVE GROUND)

A. Piping - All Sizes:

1. Tubing: Type K annealed copper tube, ASTM B88.
2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
3. Fittings: Long Radius Style, Wrought copper solder joint, ANSI B16.22.

B. Piping - 4" and Under:

1. Pipe: Standard weight galvanized steel, threaded and coupled, ASTM A53.
2. Joints: Screwed.
3. Fittings: Galvanized cast iron screwed drainage type, ANSI B16.12, long radius.

2.13 CONDENSATE DRAINAGE

A. Piping - 1-1/4" through 4":

1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
2. Pipe: Type M hard temper seamless copper drainage tube, ASTM B306.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.14 ACID WASTE AND VENT

A. Piping - All Sizes:

1. Pipe: Fire retardant polypropylene Schedule 40 drainage pipe.
2. Joints:
 - a. Join pipe and fittings with electrically fused joints. Make fittings between dissimilar materials with adapters furnished by the polypropylene pipe manufacturer.
 - b. Above Floor Only: Mechanical joint with gasket, stainless steel outer sleeve and corrosion resistant nuts and bolts or threaded fittings with gasket and compression nuts.
3. Fittings: Fire retardant polypropylene DWV pattern with socket ends for electrically fused joints.

4. Limitations: For use in non-return air plenums.
5. Acceptable Manufacturers: Orion, Fuseal, Enfield.

B. Piping – All Sizes:

1. Pipe and Fittings: Polyvinylidene fluoride (PVDF) Schedule 40 drainage pipe, ASTM E-84, UL 723.
2. Joints:
 - a. Join pipe and fittings with electrically fused joints. Make fittings between dissimilar materials with adapters furnished by the polypropylene pipe manufacturer.
 - b. Above Floor Only: Mechanical joint with gasket, stainless steel outer sleeve and corrosion resistant nuts and bolts or threaded fittings with gasket and compression nuts.
3. Fittings: Polyvinylidene fluoride (PVDF) DWV pattern with socket ends for electrically fused joints.
4. Limitations: For use in return air plenums.
5. Acceptable Manufacturers: Orion, Fuseal, Enfield.

2.15 ACID WASTE AND VENT (BELOW GROUND - INSIDE/OUTSIDE BUILDING)

A. Piping - All Sizes

1. Pipe: Non-fire retardant polypropylene Schedule 40 drainage pipe.
2. Joints: Join pipe and fittings with electrically fused joints. Make fittings between dissimilar materials with adapters furnished by the polypropylene pipe manufacturer.
3. Fittings: Non-fire retardant polypropylene DWV pattern with socket ends for electrically fused joints.
4. Acceptable Manufacturers: Orion, Fuseal, Enfield.

2.16 NATURAL GAS PIPING(ABOVEGROUND)

A. Piping – All Sizes

1. Pipe: ASTM A53, Schedule 40 Black Steel
2. Fittings: 150 lb. rating, ASME B16.3, malleable iron threaded, ASMR B16.5, flanged; ASME B16.9, steel.
3. Joints 2" and smaller:
 - a. Threaded in accessible areas. Welded in concealed areas such as shafts and plenums.
 - b. Optional: Steel compression fittings shall conform to the material and sizing requirements of ASME B16.3 or ASTM A420. Fittings shall have an HNBR O-ring seal, 420 stainless steel grip ring, and 304 stainless steel separator ring. Manufacturers: Viega #MegaPress G, NIBCO, or approved equal.
4. Joints 2 1/2" and larger:
 - a. ASME B16.25 bevelweld, ASME B16.5 flanges, or ASME B16.11 socket weld. Welded in concealed areas such as shafts and plenums.
5. Welded Fittings:
 - a. Comply with ASTM A234/A234M, ASME B16.9, ASME B16.25, and ASME B16.11.

- b. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- c. Shop fabricated Bonney Forge "Weldolet" or "Thredolet" type fittings may be used in lieu of tee fittings, but field (site) welding will not be permitted.

2.17 NATURAL GAS PIPING(UNDERGROUND)

A. Polyethylene (IPS):

- 1. Piping & Fittings:
 - a. Polyethylene (IPS), plain ends, heat fused joints. compliant with ASTM D2513, ASME D-3350, PE 2708, NFPA-54 and NFPA-58. Pipe shall be marked "Gas" and "ASTM D2513".
 - b. Manufacturers: Performance Pipe DriscoPlex 6500 Series MDPE Pipe, or Georg Fischer +.
- 2. Tracer Wire:
 - a. Copper clad steel or solid copper core tracer wire of #18 gauge (or larger) with insulation type suitable for direct burial.
- 3. Building gas service riser:
 - a. Annodeless polyethylene to steel riser, epoxy coated steel.
 - b. Manufacturers: Lyall Lyco.

2.18 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.
- B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.
- C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.19 WATER PRESSURE REDUCING VALVES

- A. PRV-1: Self-contained type up to 2-1/2" size, diaphragm actuated, with cast iron body, stainless steel springs, diaphragm, trim and seats for maximum operating pressure of 150 psig and maximum pressure drop of 100 psi. Acceptable Manufacturers: Fisher Type 95H, Cash Acme, Masoneilan, Terrice, Watts.
- B. PRV-2: 2-1/2" through 6" size, single seated plug valve, with cast iron body, stainless steel seat, maximum 125 psig inlet, 20-100 psi differential. Acceptable Manufacturers: Fisher, Masoneilan, Terrice, Watts.

2.20 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett meeting the following requirements:

1. Carrying case with handle.
 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
 4. Coordinate with the Mechanical Contractor if a meter kit is also required in specification section 23 21 00. It is not our intent to require two identical kits, rather it will be acceptable to provide only one kit to the owner which can be used with both plumbing and hydronic piping systems.
- D. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design, Preso, Armstrong, Bell & Gossett, Griswold, Gerand or Nibco Globe Style balancing valve.
- E. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett, Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.
- F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.21 SEISMIC (EARTHQUAKE) GAS SHUTOFF VALVES:

- A. 3/4" thru 4" (low and medium pressure, screwed body): UL Listed valve meeting ASCE 25-97, positive closure, soft seal seating, visual open-close indicator, manual reset, and closure time interval within 5 seconds when subjected to a sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Pacific Seismic Products #Series 300, sized for 7 psi max operating pressure, respectively.
- B. 3/4" thru 4" (high pressure, screwed body): UL Listed valve meeting ASCE 25-97, manual reset, soft seat construction for positive sealing, visual open-close indicator, tripping mechanism with non-creeping rolling latch, and closure time interval within 5 seconds when subjected to sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Pacific Seismic Products #Series 300, sized for 60 psi maximum operating pressure.
- C. 2" thru 8" (high pressure, flanged body): UL Listed valve meeting ASCE 25-97, manual reset, soft seat construction for positive sealing, visual open-close indicator, tripping mechanism with non-creeping rolling latch, and closure time interval within 5 seconds when subjected to sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Pacific Seismic Products #Series 300, sized for 60 psi maximum operating pressure.

2.22 WATER HAMMER ARRESTERS

- A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.
- B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.
- C. Air chambers shall meet the requirements of the applicable plumbing code. Minimum 12" long at fixtures and minimum 24" long on risers. Air chambers shall be the same size or larger than the piping it is connected to.

2.23 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
 - 1. Iron, steel, and stainless steel connected to each other.
 - 2. Brass, copper, and bronze connected to each other.
 - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 - 2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic, Grinnell, Matco-Norca.
- F. Flanged Joints (any size):
 - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 - 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 - 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
 - 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
 - 5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
 - 6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.24 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.25 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.26 RELIEF VALVES

- A. RV-1: (Compressed Air) Spring loaded disc type, cast iron or steel body, stainless steel disc, side outlet and lifting lever, 250# CWP. Acceptable Manufacturers: Consolidated Div. of Dresser Ind., Kunkle, Keckley.
- B. RV-2: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash, Watts.

2.27 SANITARY AND STORM VALVES – PUMPED (ABOVE GROUND)

- A. Shutoff Valves:
 - 1. Ball Valves:
 - a. 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze or brass body, stainless steel ball and trim, Teflon seats and seals. Apollo, Stockham, Milwaukee, Watts, Nibco, National Utilities Co., RUB.
 - 2. Gate Valves:
 - a. 2-1/2" thru 12", 200# CWP @ 150°F, flanged, iron body, bronze trim, OS&Y. Crane, Hammond, Stockham, Walworth, Milwaukee, Nibco.
- B. Check Valves:
 - 1. 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane, Hammond, Stockham, Walworth, Milwaukee, Watts, Nibco.
 - 2. 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co., Stockham, NIBCO, Crane.

2.28 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: 3/4" – 2", comply with ASSE 1013, Lead free, Bronze body, with corrosion resistant internal parts, two independently operating positive seating spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; assembled with two ball valves, and four test cocks. Acceptable Manufacturers: Watts, Zurn, Wilkins.
- B. Reduced Pressure Backflow Preventers: 2 1/2" – 10", comply with ASSE 1013, Lead free, FDA/NSF epoxy coated cast iron body, two independently operating positive seating spring loaded check valves, diaphragm type differential pressure relief valve located between check valves, assembled with two OS&Y gate valves, and four test cocks. Acceptable Manufacturers: Watts, Zurn, Wilkins.
- C. Double Check Valve Assemblies: 3/4" – 2", comply with ASSE 1015 or AWWA C510; Lead free, Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves, two ball valves, and four test cocks. Acceptable Manufacturers: Watts, Zurn, Wilkins.

- D. Double Check Valve Assemblies: 2 1/2" – 10", comply with ASSE 1015 or AWWA C510; Lead free, Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves, two OS&Y gate valves, and four test cocks . Acceptable Manufacturers: Watts, Zurn, Wilkins.

2.29 PIPE ESCUTCHEONS:

- A. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas. Prime zinc base paint finish is allowed for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

2.30 PIPE SLEEVES:

- A. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
- B. Sleeves shall provide a minimum 1/2" annular clearance around pipe. Where pipes cross through/ below footings or footing walls provide a minimum 1" annular clearance between sleeve and pipe.
- C. Sheet metal: Fabricate from 0.025" (0.64 mm) minimum, sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint.
- D. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
- E. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
- F. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- G. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves to extend a minimum of 1" above finished floor. Manufacturers: Adjust-to-Crete, or Crete-Sleeve, Hilti.
- H. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.
- I. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.
 - 1. Outer Sleeves: EPDM attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.

2. Water Stop Mid-Body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve.
3. Manufacturers: HoldRite #HydroFlame.

2.31 MECHANICAL SLEEVE SEALS FOR UNDERGROUND PENETRATIONS:

- A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- B. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
- C. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.
- D. Manufacturers: Metraflex #Metraseal, Advance Products & Systems #Innerlynx, or GPT #Link-Seal.

2.32 MECHANICAL SLEEVE SEALS-ABOVEGROUND PENETRATIONS:

- A. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
- B. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.
- C. Wood Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE, Hydroflame Sleeve.
 2. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
 3. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
 4. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested according to ASTM E 814 or ANSI/UL 1479.
- D. Steel Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite; Hydroflame CMD Metal Deck Device.
 2. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.

3. Includes a cone attached to the base for extending the device through the metal deck and a water stop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
 4. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.
- E. Concrete Description: Cast-in-place, watertight tub box drain block out firestop device for use in floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke and fire, and hot gasses.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite, Hydroflame Tub Box.
 2. Consists of a reinforced polymer box containing a 2-1/2-inches (63.5 mm) thick polystyrene foam insert with an upper water seal consisting of absorbent material and a pitched water trough.
 3. Include a sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
 4. Include two support legs each with a radial extended flange for balance and for fastening to concrete formwork, and a lower water-seal and radial extended flange attached to the lower end of the sleeve for fastening to concrete formwork and a water stop gasket with three concentric raised rings for embedment and sealing to the concrete slab.
 5. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.

2.33 THERMOMETERS AND GAUGES

A. General:

1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
2. No mercury shall be used in thermometers due to hazardous material classification.
3. Manufacturers: Weksler, Winters, Trerice, Marshalltown or US Gauge.

B. Thermometers:

1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
 - a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
 - b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
 - c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
 - d. Stem: Stainless steel, adjustable angle socket, length to suit installation.
2. Glass Thermometer: Provide adjustable angle 9" thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
 - a. Case: Aluminum or reinforced plastic.
 - b. Temperature Sensitive Gage Liquid: Organic non-toxic. No mercury permitted.

- c. Scale: Aluminum painted white with black markings.
 - d. Connection: 1/2" NPT with thermowell or 1-1/4" UNF swivel nut without thermowell.
 3. Photovoltaic Cell Powered LCD Thermometer
 - a. Case: ABS Plastic
 - b. Accuracy: 1% of full scale.
 - c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
 - d. Connection: 3/4" NPT with thermowell or 1-1/4" UNF swivel nut without thermowell.
 4. Conform to the following temperature ranges:
 - a. Hot Water: 20°F - 240°F with 2°F scale divisions.
 - b. Cold Water: -40°F - 160°F with 2°F scale divisions.
- C. Thermometer Test Wells:
 1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- D. Temperature Gauge Connector Plugs:
 1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Construct of brass and finish in nickel-plate, equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" OD probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.
- E. Pressure Gauges:
 1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
 2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
 3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
 4. Connector: Brass with 1/4" male NPT.
 5. Scale: White coated aluminum, with permanently etched markings.
 6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.
- F. Pressure Gauge Cocks:
 1. General: Provide pressure gauge cocks/valves between pressure gauges and gauge tees on piping systems. Two-piece bronze body ball valve with threaded ends. Manufacturers: Milwaukee #BA-100.
 2. Snubber: 1/4" brass or stainless steel bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating. Manufacturers: Wika #910.12, or Ashcroft #1112.
- G. Pressure Gauge Connector Test Plugs:

1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Constructed of lead-free brass, with 1/4" or 1/2" NPT fitting, with self-sealing valve core type neoprene or Buna-N gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

END OF SECTION

SECTION 22 11 23
PUMPS AND SPECIALTIES

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 1. Variable flow domestic water booster pump systems
 2. Constant flow domestic water booster pump systems
 3. Sump pumps
 4. Sewage ejectors
 5. In-line circulators
 6. Expansion tanks - diaphragm type pre-pressurized.
 7. Air elimination valve.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Plumbing Materials and Methods
- B. Section 224000: Plumbing Fixtures
- C. Division 26.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.
- B. Codes and Standards: Provide pumps which conform to the requirements of:
 1. Hydraulic Institute (HI): Manufacturer pumps in accordance with "Standards for Centrifugal Rotary and Reciprocating Pumps."
 2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
 3. National Fire Protection Association (NFPA) 70: National Electrical Code.
 4. Underwriters Laboratories (UL) UL-778: Motor Operated Water Pumps.

1.05 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
 - 1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.
 - 2. Submittal information to verify all scheduled characteristics are met including efficiency.
- B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.
- C. Maintenance Data:
 - 1. Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists.
 - 2. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.
- D. Wiring Diagrams:
 - 1. Submit manufacturer's ladder-type wiring diagrams for power and control wiring required.
 - 2. Differentiate between factory-installed and field-installed wiring.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 220500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 DOMESTIC WATER VARIABLE FLOW BOOSTER PUMP SYSTEM

- A. Furnish and install a UL listed prefabricated pump water pressure booster system, simplex, duplex or triplex as schedules on the drawings.
 - 1. Refer to scheduled equipment on Contract Drawings for capacities of pumps and motors.
- B. Pumps
 - 1. Pumps shall be single stage end-suction design of cast iron bronze fitted construction, equipped with mechanical shaft seal. Or, multi-stage, vertical inline design with cast iron stainless steel fitted construction.
- C. Drip-Proof Type Motor
 - 1. Each pump motor shall be premium efficient TEFC (suitable for use with VFD's) and selected to not exceed the service factor of the nameplate horsepower at any point on the pump capacity head curve. ECM are recommended.
 - 2. Each pump shall be fitted with isolation valves and union connections or flanges to facilitate future service requirements.
 - 3. Each pump shall be furnished with a silent check valve with bronze trim.
- D. Power and Control Panel
 - 1. The control panel shall include the following components:
 - a. Main power disconnect, non-fused.
 - b. Control circuit transformer with fused secondary.
 - c. Variable frequency drive for each pump
 - d. Digital programmable logic controller (PLC) with PID control functions.
 - e. Color graphic touch screen display, minimum 6" diagonal, mounted on the panel door with display units in selectable language and engineering units.
 - f. Audible general fault alarm, including a push to silence button and a set of dry contacts wired to a terminal strip for remote monitoring.
 - g. The PLC shall be capable of connection to a Building Automation System (BAS) using BACnet, Modbus or LonWorks protocol as defined in Division 23.
 - h. The control logic shall include a dynamic set point adjustment, which automatically lowers or increases the system discharge operating pressure set point as the system demand changes in accordance with local energy code. Manufacturers without this feature shall provide their discharge pressure transducer loose and installed at the furthest remote location of the system to account for variable friction losses within the piping system.

- i. The control logic shall automatically stage pumps and adjust the pump speed based on discharge pressure control. The lead and lag pumps shall be rotated after each system shutdown. The controls shall start a lag pump on lead pump failure. The controls shall include pump minimum run time and pump maximum run time adjustable set points.
- j. The control logic shall include an energy saving proof of no system demand and automatically shutdown the lead pump if no demand is proven. The lag pump(s) shall shutdown when operated at minimum speed for an adjustable elapsed time.
- k. Compliant with UL 508.

E. Factory Prefabrication

1. The entire booster system shall be factory prefabricated on a common structural steel stand with all interconnecting piping and wiring completed and hydrostatically tested prior to shipment.
2. Purge valve shall be thermally actuated to notify control panel of over-temperature conditions to initiate an alarm and shutdown system.
3. The complete package shall also include isolation valves on the suction and discharge of each pump. Stainless steel suction and discharge pipe manifolds, as well as copper tubing with shutoff cocks for gauges and pressure switches, will be furnished assembled. Provide pressure gauges to read suction and discharge pressures for field verification without accessing control system.
4. Field connections include connection to the system suction and discharge headers, drain tube, piping to the hydropneumatic pressure tank with union ball valve, and the power connection at the control panel.

F. Hydropneumatic Tank:

1. A hydropneumatic tank shall be included by booster skid manufacturer to facilitate low flow conditions.
2. Tank shall be a full acceptance replaceable bladder style, sized at 65% acceptance volume, and include a union isolation valve, tank drain and pressure gauge.
3. Tank may be shipped loose for field installation as indicated on the plans.
4. Tank shall be ASME constructed with ring base and minimum pressure rating of 125 psi.

G. Manufacturer: SyncroFlo, Patterson #Aqua FloPac, Flowtherm #FMV Series, Federal, Grundfos, Xylem Bell & Gossett, QuantumFlo or equal.

2.02 DOMESTIC WATER CONSTANT SPEED BOOSTER PUMP SYSTEM

A. Furnish and install a prefabricated three-pump water pressure booster system.

1. Refer to scheduled equipment on Contract Drawings for capacities of pumps and motors.

B. Pumps:

1. Pumps shall be single stage end-suction design of cast iron bronze fitted construction, equipped with mechanical shaft seal. No lead content.
2. Each pump shall have vibration-isolating mounts and be fitted with a separate prewired temperature probe and approved electrical purge valve installed immediately upstream of each PRV.

C. Drip-proof type motor.

1. Each pump motor shall meet NEMA standards and operate within the nameplate horsepower at any point on the pump capacity head curve. ECM are recommended.
- D. Pressure Regulating Valves:
1. Constant system pressure shall be maintained by a flanged pilot operated diaphragm type combination pressure regulating and non-slam check valve on each pump discharge line.
 2. Valve body shall be cast iron with epoxy coated cover and brass or epoxy coated disc guide, disc retainer, and diaphragm washer.
 - a. The valve body shall be suitable for operation at maximum pump pressure plus maximum suction pressure.
 3. Staging control shall be as noted on the plans and schedule; standard staging control shall be current staging.
 - a. Controls shall include a “no-flow shut down” function that will disable the lead pump during periods of no water demand on the system.
 - b. Control features shall include minimum run timers, automatic lead/lag alternation, low suction pressure cut-out, and lead pump failure protection to automatically start the lag pump when an overload condition occurs on the lead pump.
- E. Power and Control Panel:
1. Furnish a single enclosure power and control panel (NEMA 1).
 2. Enclosure shall be steel and furnished with an industrial grade enamel.
 3. It shall house all control components and include 115-volt control transformer with control power switch, indicating lights, auto alternator, audio-visual alarm system, and other necessary controls.
 4. Include for each pump a fused disconnect switch with external operating handle, a magnetic starter with 3-leg overload protection, a running light, and a multiple position selector switch.
 5. All of the above shall be factory internally prewired and tested in accordance with the provisions of the National Electrical Code.
 6. All control wires shall be individually numbered and each component shall be labeled accordingly.
 7. All internal wiring shall be copper stranded, AWG with a minimum insulation of 90°C.
 8. The complete assembly shall have the UL listing mark for industrial control panels.
- F. Instrumentation and Emergency Controls:
1. Each pump shall anti-vibration pads, a temperature probe, and an electric purge valve.
 - a. Include individual pressure gauges for indicating each pump, system, and suction pressure.
 - b. Include pressure switch for abnormally low suction pressure to activate the automatically reset alarm system.
- G. Factory Prefabrication:
1. The entire booster system shall be factory prefabricated on a common structural steel stand with all interconnecting piping and wiring completed and hydrostatically-tested prior to shipment.

2. The complete package shall also include isolation valves on the suction and discharge of each pump.
3. Stainless steel suction and discharge pipe manifolds, as well as copper tubing with shutoff cocks for gauges and pressure switches, will be furnished assembled.
4. The only field connections required will be system suction and discharge headers, the temp probe drain tube, piping of the hydropneumatic pressure tank with union ball valve, and the power connection at the control panel.

H. Hydropneumatic Tank:

1. A tank shall be included by booster skid manufacturer.
2. Tank shall be a full acceptance replaceable bladder style and include a union isolation valve, tank drain and pressure gauge.
3. Tank shall be skid mounted and piped shipped loose for field installation as indicated on the plans.

I. Manufacturer: SyncroFlo, Patterson #Aqua FloPac, Federal Pumps, Grundfos, Xylem Bell & Gossett, or equal.

2.03 DUPLEX SUMP PUMP SYSTEM

A. Furnish and install duplex submersible sump pump, Weil Pump Series 1600 or equal, as scheduled and shown on drawings.

B. Motors shall be air filled design.

1. Oil filled motor shells shall not be considered equal.
2. Motor end bell shall be designed as a terminal box and separated from the motor shell by a combination bearing support and inspection plate.
3. The inspection plate shall permit viewing and access to the motor from the top side of the motor.
4. Motors shall be housed in a watertight cast iron shell with extended cooling fins and shall have Class "F" insulation and permanently lubricated double seal ball bearings having a rated life of 17,500 hours.
5. Motors using sleeve type bearings will not be considered equal. The mating surfaces between the motor end bell, motor shell and seal housing shall be sealed by means of "X" cross section QUAD RINGS.
6. Motor shaft shall be 300 series stainless steel with keyway for positive positioning of impeller.
7. Carbon steel shafts are not considered equal.

C. The impeller shall be multi-vane and shall be made of close grained bronze and accurately machined to the proper diameter and to be statically and dynamically balanced.

D. A double mechanical seal system shall be furnished.

1. The entire double mechanical seal assembly shall be housed in a seal chamber filled with clean dielectric oil. Seal surfaces shall be of solid silicon carbide variety.
2. Carbon ceramic, tungsten carbide or systems that allow the lower seal mechanism to come in contact with the pumped media, shall not be considered as equal.

- E. Each pump shall be computer tested and a report of the test will be kept.
1. Test data will consist of 6 duty points at various heads and capacities, one of which will be the design point.
 2. Test data will include actual efficiencies; horsepower requirements and amp draw at each point.
 3. This test data will be made available to the engineer and owner upon request.
- F. Furnish remote packaged factory pre-wired duplex pump controller, Weil 8101E with the following:
1. NEMA 4 double door dead front steel lockable enclosure.
 2. Magnetic starter with overload reset through inner door, each pump.
 3. Fused disconnect switch with handle through inner door, each pump.
 4. Automatic alternator separately fused.
 5. Overload reset buttons, each pump.
 6. Running lights, each pump.
 7. H-O-A switches, each pump.
 8. Control circuit transformer for 120V operation for each pump independently.
 9. Output connections for high water annunciation at Simplex system.
 10. Alarm silencing switch.
 11. Alarm light with flasher.
 12. Numbered and wired terminal strip.
 13. Alarm output contact for connection to Building Management System
 14. Single point electrical connection.
 15. All wiring between control panel and pump provided under Division 22.
- G. Furnish and install Weil Series 8230 mercury float switches complete with galvanized rod and wall support bracket.
1. Each pump control switch will consist of 2 normally open mercury switches, encapsulated in epoxy resin.
 2. The float casing will be polypropylene.
 3. The switch cable will be type STO PVC jacket 4 #18 conductor, 41 strand, 600-volt insulation.
 4. The cable will be secured to the support rod with a polypropylene composition clamp with stainless steel bolts.
 5. Switches used for high water alarm service will be of the same construction as the pump switches, except that 2-conductor cable will be furnished.
 6. The switch housing will be color-coded to distinguish between the pump and alarm switches.
 7. All wiring between control panel and float switches provided under Division 22.
- H. Provide reinforced fiberglass basin with steel anti-flotation ring. Provide with matching gasketed steel cover.

1. Install basin and pour concrete all around to secure in place.

I. Warranty:

1. The pump manufacturer shall warrant the pumps being supplied to the owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service.

2. All repairs or replacement parts that may be needed on the seventeenth month following final acceptance by owner will be made and the cost (F.O.B. factory) pro rated for the period of time the pump has been in operation.

3. The warranty shall be in published form and apply to all similar units.

J. Manufacturer: Weil, Weinmann, Enpo-Cornell, Homa, or equal.

2.04 DUPLEX SUBMERSIBLE SEWAGE EJECTOR

A. Furnish and install a duplex submersible sewage ejector system, Weil Pump Series 2500 or equal, as scheduled and shown on drawings.

B. The pump casing shall be one piece cast iron constructed with tripod support legs that provide an even distribution of weight.

C. The mating surfaces between the motor end bell, the motor shell and the seal chamber shall be sealed by means of "X" section QUAD RINGS. Designs using conventional circulate 'O' rings or rectangular cross sectional gaskets shall not be considered equal.

D. Pump motor shall be vertical, NEMA-6 and of an air filled, hermetically sealed design for premium efficiency. Oil filled shell shall not be considered equal.

E. Motor end bell shall be cast iron, designed as a terminal box and separated from the motor shell by a combination bearing support and inspection plate.

F. The motor shall be housed within a water tight, heavy duty cast iron shell with integral extended cooling fins. Motor shall have Class 'F' insulation and permanently lubricated, double sealed ball bearings having a minimum life of 17,500 hours. Motors using sleeve type bearings shall not be considered equal.

G. Motor shaft shall be 300 series stainless steel with keyway for positive positioning of impeller. Motors using carbon steel shafts or stainless stub shafts shall not be considered equal.

H. Impeller shall be multi-vane design, constructed of bronze, accurately machined and dynamically balanced to the job site conditions. The impeller shall not require the use of wearing rings to insure proper operation and shall be capable of passing 4 inch minimum solids.

I. A double mechanical seal system shall be furnished and housed in a machined cast iron seal chamber filled with clean dielectric oil, providing constant lubrication. Lower seal surfaces shall be of solid silicon carbide to provide longer life. Carbon ceramic, tungsten carbide or systems that allow the lower seal surfaces to come in contact with the pumped media, shall not be considered equal.

- J. Each pump shall be tested and a computer generated report will be kept in file and made available upon request. The reported test data shall consist of six duty points of various heads and capacities, one of which will be the design point and shall include actual efficiencies and horsepower requirements.
- K. Furnish remote packaged factory pre-wired duplex pump controller with the following:
1. NEMA 1 double door dead front steel lockable enclosure.
 2. Magnetic starter with overload reset through cover, each pump.
 3. Fused disconnect switch with handle through cover, each pump.
 4. Automatic alternator, separately fused.
 5. Overload reset buttons, each pump.
 6. Running lights, each pump.
 7. H-O-A switches, each pump.
 8. Control circuit transformer for 120V operation for each pump.
 9. Output connection for hi-water annunciation at Simplex.
 10. Alarm silencing switch.
 11. Alarm light with flasher.
 12. Numbered and wired terminal strip.
 13. Single point electrical connection.
 14. All wiring between control panel and pump provided under Division 22.
- L. Furnish remote packaged factory pre-wired duplex pump controller with the following:
1. NEMA 4X, UL listed label enclosure
 2. PLC with color touch-screen and BMS communication via Modbus
 3. Isolated contacts for high water, pump on, and motor overload
 4. Motor overload protection (one per pump). Instantaneous magnetic trip for short circuit protection. Field adjustable within the full load amp range.
 5. One lockable panel disconnect; through-the-door style with door interlock.
 6. Lockable pump disconnects; one for each motor.
 7. Automatic alternator.
 8. Power supply for control circuit; transient surge voltage protection.
 9. High water alarm, 95 dB horn with silence button on touch screen.
 10. Auto, Off, Hand, and Test modes of operation via touch screen.
 11. Exercise feature - provides a brief run cycle for prolonged idle pumps.
 12. PLC shall display the following:
 - a. Pump run status and amperage draw.
 - b. High water alarm and general alarm indication.
 - c. Pump status icons for On/Off, Run and Disabled.
 - d. Sump tank level bar graph (if using level transmitter).
 - e. Lead pump display; next pump to start on sequence alternation.

- f. Alarm history, date and time stamped.
 - g. Alarms with self-help diagnostics to assist fault troubleshooting.
 - h. Preventive maintenance reminder.
 - i. Hour meter; one per pump and resettable.
13. Control terminal board, numbered and wired.
14. Single point electrical connection. All wiring between control panel and pump provided under Division 22.
- M. Furnish and install diaphragm pressure activated micro switches complete with galvanized mounting rod and wall support bracket. The single-pole switch shall be normally open, closing on liquid rise. Switch shall have a 3 inch OFF activation range and an 8-1/2 inch ON activation range. The 16/3 switch cord shall have a breather tube for equalization to atmospheric pressure, be rated for 10 amps, and have three wires black/white/green. Switches used for high water alarm service will be of the same construction as the pump switches. Manufacturer: Weil #8220 Series or equal.
- 1. All wiring between control panel and float switches provided under Division 22.
- N. Furnish and install four float-type mechanical switches with gold-plated contacts for intrinsically safe circuits. Floats containing mercury will not be permitted. Each tethered switch shall include a cord grip and strap mount for mounting to a 3/4" or 1" diameter pipe.
- 1. All wiring between control panel and float switches provided under Division 22.
- O. Furnish and install a level transmitter and base with 316 stainless steel housing and a sturdy base for wet well floor placement. Transmitter to use a piezo resistive sensing element, have a maximum operating temperature of 176°F, maximum sump depth of 23 feet., and a power requirement of 10-28 Vdc. Transmitter shall be UL approved intrinsically safe.
- 1. All wiring between control panel and transmitter provided under Division 22.
 - 2. Transmitter may be mounted to a pipe, suspended from wet well, or position on basin floor; refer to Drawings for mounting configuration.
- P. Warranty:
- 1. The pump manufacturer shall warrant the pumps being supplied to the owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service.
 - 2. All repairs or replacement parts that may be needed after the initial sixteen months will be made and the cost (FOB factory) pro-rated for the period of time the pump has been in operation.
 - 3. The warranty shall be in published form and apply to all similar units.
- 2.05 DUPLEX COLUMN SEWAGE EJECTOR
- A. Furnish and install a duplex column sewage ejector system as scheduled and shown on drawings.
- B. The mating surfaces between the motor end bell, the motor shell and the seal chamber shall be sealed by means of "X" section QUAD RINGS. Designs using conventional circulate 'O' rings or rectangular cross sectional gaskets shall not be considered equal.

- C. Motor end bell shall be cast iron, designed as a terminal box and separated from the motor shell by a combination bearing support and inspection plate.
- D. The motor shall be housed within a heavy duty cast iron shell with cooling fins.
 - 1. Motor shall have Class 'F' insulation and permanently lubricated, double sealed ball bearings having a minimum life of 17,500 hours.
 - 2. Motors using sleeve type bearings shall not be considered equal.
- E. Motor shaft shall be 300 series stainless steel with keyway for positive positioning of impeller.
 - 1. Motors using carbon steel shafts or stainless stub shafts shall not be considered equal.
- F. Impeller shall be multi-vane design, constructed of bronze, accurately machined and dynamically balanced to the job site conditions.
 - 1. The impeller shall not require the use of wearing rings to insure proper operation and shall be capable of passing 2-1/4 inch minimum solids.
- G. A double mechanical seal system shall be furnished and housed in a machined cast iron seal chamber filled with clean dielectric oil, providing constant lubrication.
 - 1. Lower seal surfaces shall be of solid silicon carbide to provide longer life.
 - 2. Carbon ceramic, tungsten carbide or systems that allow the lower seal surfaces to come in contact with the pumped media, shall not be considered equal.
- H. Each pump shall be tested and a computer generated report will be kept in file and made available upon request.
 - 1. The reported test data shall consist of six duty points of various heads and capacities, one of which will be the design point and shall include actual efficiencies and horsepower requirements.
- I. Furnish remote packaged factory pre-wired duplex pump controller, Weil 8101E with the following:
 - 1. NEMA 4 double door dead front steel lockable enclosure.
 - 2. Magnetic starter with overload reset through inner door, each pump.
 - 3. Fused disconnect switch with handle through inner door, each pump.
 - 4. Automatic alternator separately fused.
 - 5. Overload reset buttons, each pump.
 - 6. Running lights, each pump.
 - 7. H-O-A switches, each pump.
 - 8. Control circuit transformer for 120V operation for each pump.
 - 9. Output connection for hi-water annunciation at Simplex.
 - 10. Alarm silencing switch.
 - 11. Alarm light with flasher.
 - 12. Numbered and wired terminal strip.
 - 13. Single point electrical connection.
 - 14. All wiring between control panel and pump provided under Division 22.

- J. Furnish and install diaphragm pressure activated micro switches complete with galvanized mounting rod and wall support bracket. The single-pole switch shall be normally open, closing on liquid rise. Switch shall have a 3 inch OFF activation range and an 8-1/2 inch ON activation range. The 16/3 switch cord shall have a breather tube for equalization to atmospheric pressure, be rated for 10 amps, and have three wires black/white/green. Switches used for high water alarm service will be of the same construction as the pump switches. Manufacturer: Weil #8220 Series or equal.
1. All wiring between control panel and float switches provided under Division 22.
- K. Provide reinforced fiberglass basin with steel anti-flotation ring.
1. Provide with matching gasketed steel top by pump manufacturer.
 2. Install basin and pour concrete all around to secure in place.
- L. Warranty:
1. The pump manufacturer shall warrant the pumps being supplied to the owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service.
 2. All repairs or replacement parts that may be needed after the initial sixteen months will be made and the cost (F.O.B. factory) pro rated for the period of time the pump has been in operation.
 3. The warranty shall be in published form and apply to all similar units.
- M. Removal System (Optional)
1. The pump removal system shall permit removal and re-installation of a pump without disturbing the discharge piping. Personnel shall not be required to enter the wet well. The pump shall be guided by two guide poles (by others). The guide poles shall be mounted on the floor elbow and a 304 stainless steel upper guide bracket. Pump sliding bracket will iron. The floor elbow shall be constructed of ASTM A48-83 class 30 close-grained cast iron. The pump sliding bracket shall act as a wedge type coupling between the pump and floor elbow. This insures a metal-to-metal, watertight fit. Systems that require gaskets, diaphragms, or o-rings to ensure a watertight fit shall not be considered equal.
- N. Manufacturer: Weil #2100/2200 Series, Weinmann, Grundfos, Enpo-Cornell, or equal.

2.06 SIMPLEX SUMP PUMP SYSTEM

- A. Provide where indicated on drawings, a Simplex submersible sump pump. Pump to have a 2" I.P.S. discharge, bronze fitted construction with submersible sealed motor, stainless steel shaft, bronze impeller, mechanical seal, and waterproof power cord. Pump to have 50 GPM flowrate minimum. Motors to be as scheduled. Pump shall have a fully submersible float switch for mounting on pump discharge pipe.
- B. Provide with differential mercury float switches for (1) on-off operation and (2) high water alarm.
- C. Provide check valve and shut-off valve on discharge side of pump.
- D. High water alarm: Local alarm with dry contacts for connection to BAS.
- E. Warranty: One year.

- F. Manufacturer: Meyers S-25, Weil, Federal, Liberty, Zoeller, Homa, or equal.

2.07 IN LINE WATER LUBRICATED CIRCULATING PUMPS (SECONDARY PUMPING AND BOOSTER APPLICATIONS)

- A. Furnish and install pumps with capacities as shown on plans. Pumps shall be in-line type for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing piping connections.
- B. Pump body shall be of all bronze construction, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.
- C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.
- D. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225° F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
- E. Motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans. ECM are recommended.
- F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.
- G. Provide H-O-A switch with overload protection. Pump shall run continuously. Wiring between switch and pump provided under Division 22, as stated in Section 220500.
- H. Manufacturer: Xylem Bell and Gossett, TACO, Armstrong, Grundfos, or equal.

2.08 VERTICAL TURBINE PUMP

- A. General:
 - 1. This specification covers a lineshaft turbine pump with above ground discharge, the lineshaft bearings lubricated by the water being pumped and furnished with suitable driver and accessories as specified herein. The pumping unit shall be designed and furnished in accordance with the latest Hydraulic Institute and AWWA Standards for lineshaft turbine pump.
 - 2. Refer to drawings for project specific performance requirements.
- B. Pump Construction
 - 1. Bowl assembly: The bowls shall be flanged type constructed of close grained cast iron conform to ASTM A48, class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fit- ted to close tolerances. They shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated flow or 1.5 times shut-off head, whichever is greater. The intermediate bowls shall have enamel or epoxy lined waterways for maximum efficiency and wear protection. All intermediate bowls shall be of identical design for interchangeability. All the bowls shall be fitted with sleeve type bearings of bronze alloy C89835.

2. Impellers: The impellers shall be constructed from ASTM B584 Silicon Bronze. They shall be free from defects and must be accurately cast, machined and filed for optimum performance and minimum vibration. Impellers shall be balanced to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks of C1018 steel (or key and split thrust ring of SS).
3. Suction: The suction bowl or suction bell shall be provided with a non-soluble grease packed bronze bearing.
4. A bronze or 304 Stainless Steel sand collar shall be provided to protect this bearing from abrasives in the pumping fluids. The bearing housing shall have sufficient opening at the bottom for easy removal of the bearing. A cone or basket type strainer shall be provided. It shall have a net inlet area equal to at least three times the impeller inlet area. The maximum opening shall not be more than 75% of the maximum opening of the water passage through the bowl or impeller.
5. Shaft: The bowl shaft shall be constructed from ASTM 582 type 416 stainless steel. It shall be precision ground and polished with surface finish better than 40 RMS.

C. Column Assembly - Open Line Shaft

1. Column pipe: The column pipe shall be furnished in sections not exceeding a nominal length of 10 ft. and shall be connected by threaded-sleeve couplings (or flanges). Pump speeds between 2200 RPM and 3600 RPM shall have intermediate column length and bearing spacing no greater than 5 feet. The length of the top and bottom sections shall not be more than 5 ft. The pipes shall be of ASTM A53 grade B steel pipe and the weight shall be not less than Schedule 30. The end of the pipe shall be with 8 threads per inch with 3/16" taper per foot thread and faced parallel to butt against the centering spiders of ASTM B584 Silicon Bronze or 304 Stainless Steel to form accurate alignment. All column flange faces shall be parallel and machined for rabbet fit to permit accurate alignment. The inside diameter of the pipe shall be such that the head losses shall not be more than 5 feet per 100 feet of pipe or the flow velocity not to exceed 3 ft./sec based on rated flow of the pump.
2. Line shaft: The line shaft shall be of ASTM A582 type 416 stainless steel ground and polished with surface finish not to exceed 40 RMS. They shall be furnished in interchangeable section not over ten feet in length, and shall be coupled with threaded stainless steel couplings (up to 2-15/16" diameter) machined from solid steel bar. It shall have left-hand thread to tighten during pump operation. The diameter of the shaft and coupling shall be de- signed in according with AWWA E101 Standard.
3. Bearing: Bearing shall be fluted rubber retained in the centering spider by a shoulder on each end of the bearing.

D. Discharge Head Assembly

1. Discharge Head: It shall be of the high profile type to allow shaft coupled above stuffing box and provided for mounting the driver and support the column and bowl assemblies. It shall be of high-grade cast iron, ASTM A48
2. Class 30, or fabricated steel. The above ground outlet shall be flanged, ANSI class 125 (for cast iron) or class 150 (for steel). It shall have a 1/2" NPT connection for a pressure gauge.
3. Stuffing Box: The stuffing box shall be cast iron and shall contain a minimum of five rings of packing (or mechanical seal). It shall have a pressure relief connection. The packing gland shall be a 316 SS split type secured in place with non-corrosive studs and nuts. The bearing shall be C89835 bronze. A rubber slinger shall be secured to the shaft above the packing gland.

E. Electric Motor

1. The motor shall be a heavy duty squirrel cage induction type, NEMA Class B or Class F insulation with vertical hollow or solid shaft motor, with a non-reverse ratchet, or self-release coupling, to prevent reverse rotation of the rotating elements. A thrust bearing of ample capacity to carry the weight of all rotating parts plus the maximum hydraulic thrust load under all conditions of operation calculated L10 life shall be no less than 8800 hours. Provision shall be made for momentary upthrust equal to 30% of the rated down thrust. The motor shall be premium efficiency, 1.15 service factor, and suitable for use on available voltage at three phase, 60 Hz electric service.
2. When vertical hollow shaft motor is used, an adjusting nut shall be provided at the top of the motor for setting the impeller to bowl running clearance. When vertical solid shaft motor is used, an adjustable shaft coupling shall be provided at the discharge head for setting the impeller to bowl running clearance.

F. Manufacturers: Goulds, Taco, or equal.

2.09 WELL JET PUMP

- A. Furnish and install pumps with capacities as shown on plans. Pumps shall be close coupled, single stage, capable of being serviced without disturbing piping connections.
- B. Pump volute shall be cast iron, and impeller shall be Noryl, dynamically balanced.
- C. Pumps shall be rated for maximum of 50 psi working pressure. Casings shall have gauge ports, and vent and drain ports at top and bottom of casing.
- D. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. It shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed. Provide premium efficiency motors in accordance with Section 220500.
- E. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
- F. Each pump shall be checked by the contractor and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to pump for owner's reference.
- G. Manufacturer: Pentair Berkeley #SN Series or equal.

2.10 EXPANSION TANKS

- A. Diaphragm Type Pre-pressurized:
 1. The pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. Bladder shall be heavy duty butyl, FDA approved.

2. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi and pre-charged to the minimum operating pressure. Tank shall be epoxy lined.
3. Manufacturer: Wessels #FXA Series, Amtrol, or equal.

2.11 AIR ELIMINATION VALVE (AUTOMATIC)

- A. Air shall be eliminated to the atmosphere as fast as it is separated from system water, through a float activated remote pressure operated, air elimination valve installed at the top of the air separator.
- B. The air elimination valve shall have a high removal rate at low pressure differentials and shall be fully open for the removal of air at all pressures in the operating range from 2 to 150 psig. It shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
- C. The air elimination valve shall be constructed of metal and all working parts shall be non-corrosive. Working pressure shall be 125 psi.
- D. Provide minimum 3/8" drain line from vent and route to nearest floor drain or floor sink or other approved drainage location.
- E. Manufacturer: Amtrol, Hoffman or equal.

2.12 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
 5. Variable motor speed to be controlled by a 0 to 10 Vdc or 4 to 20 mA input.
 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

EXECUTION

3.01 INSTALLATION

- A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Grouting Pump Base: For all base mounted flexibly coupled pumps fill the pump base frame with grout after completing pump/motor alignment.
- C. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc, as specified in related specification sections.

- D. For variable flow pumping applications, see Section 230902 Variable Frequency Drives for additional requirements.
- E. Contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.
- F. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.
- G. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.
- H. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by trimming the impeller to match the load.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours of travel from the jobsite.

END OF SECTION

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SECTION 22 13 19

DRAINS

PART 1 GENERAL

1.01 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A112.21.1 - Floor Drains.
 - 2. ANSI A112.21.2 - Roof Drains.

PART 2 PRODUCTS

2.01 FLOOR DRAINS AND SINKS

- A. Interior Floor Drain: ASME A112.21.1; lacquered cast iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
- B. Interior Floor Drain: ASME A112.21.1; lacquered cast iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable [round] [square] nickel-bronze strainer with removable perforated sediment bucket.
- C. Interior Floor Drain: ASME A112.21.1; lacquered cast iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze extra heavy duty strainer.
- D. Interior Floor Drain: ASME A112.21.1; lacquered cast iron two-piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze extra heavy duty strainer with hinged grate and sediment bucket.
- E. Exterior Surfaced Areas: [Round] [Square] cast nickel bronze access frame and non-skid cover.
- F. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- G. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

2.02 FLOOR SINKS

- A. Lacquered cast iron body with dome strainer and seepage flange.
- B. [Round] [Square] lacquered cast iron body with integral seepage pan, epoxy coated interior, aluminum dome strainer, clamp collar, sediment bucket, epoxy coated, nickel bronze frame and [full] [half] grate.

Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

2.03 ROOF DRAINS

- A. Roof Drain: Assembly: ASME A112.21.2M, Body: [Lacquered] [Galvanized] cast iron with sump, Strainer: Removable cast iron dome with vandal proof screws, Accessories: Coordinate with roofing type:
1. Membrane flange and membrane clamp with integral gravel stop.
 2. Adjustable under deck clamp.
 3. Roof sump receiver.
 4. Waterproofing flange.
 5. Controlled flow weir.
 6. Leveling frame.
 7. Adjustable extension sleeve for roof insulation.
 8. Perforated or slotted ballast guard extension for inverted roof.
 9. Perforated stainless steel ballast guard extension.
- B. Overflow Drain: Assembly: ASME A112.21.2M, Body: [Lacquered] [Galvanized] cast iron with sump, Strainer: Removable cast iron dome with vandal proof screws, Accessories: Coordinate with roofing type:
1. Membrane flange and membrane clamp with integral gravel stop.
 2. Adjustable under deck clamp.
 3. Roof sump receiver.
 4. Waterproofing flange.
 5. Controlled flow weir.
 6. Leveling frame.
 7. Adjustable extension sleeve for roof insulation.
 8. Perforated or slotted ballast guard extension for inverted roof.
 9. Perforated stainless steel ballast guard extension.
 10. 2" water dam.
- C. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

2.04 CANOPY AND CORNICE DRAINS

- A. [Lacquered] [Galvanized] cast iron body with aluminum flashing clamp collar and [epoxy coated] [nickel bronze] flat strainer.
- B. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

2.05 DOWNSPOUT NOZZLES

- A. Product Description: [Cast] [Nickel] [Polished] bronze body and wall flange round with [straight] [offset] bottom section.
- B. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

3.06 AREA DRAINS

- A. Area Drain: ASME A112.21.1M; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
 - 1. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

- B. Area Drain:

- 1. Assembly: ASME A112.21.1M. Body: Lacquered cast iron with sump. Strainer: [Round] [Square] nickel-bronze.
 - 2. Accessories: Membrane flange and membrane clamp with integral gravel stop, with [adjustable under deck clamp] [roof sump receiver] [waterproofing flange] [leveling frame] [adjustable extension sleeve (for insulation)] [perforated or slotted ballast guard extension for inverted roof] [perforated stainless steel ballast guard extension].
 - 3. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

3.07 EXTERIOR PLANTER DRAINS

- A. ASME A112.21.1M; lacquered cast iron body with sump, Strainer: Removable cast iron dome with [stainless steel] [bronze] screen, Accessories: Membrane flange and membrane clamp with integral gravel stops.
 - 1. Acceptable Manufacturers: MIFAB, J. R. Smith or Zurn.

END OF SECTION

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SECTION 22 15 00
COMPRESSED AIR EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- B. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- C. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- D. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- E. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

PART 2 PRODUCTS

2.01 TYPE

- A. Provide simplex compressor unit consisting of single-stage, air-cooled motor-compressor, air receiver, filter regulator, rubber isolators, and operating controls.
- B. Acceptable Manufacturers: Ingersoll-Rand, Champion, Quincy, or Curtis.

2.02 COMPRESSOR CONSTRUCTION

- A. Construct compressor with cast iron housing and head, heat treated forged steel or ductile iron shaft, aluminum alloy connecting rods, aluminum pistons with non-lubricated carbon rings, and high-strength alloy suction and discharge valves. Statically and dynamically balance rotating parts.
- B. Provide oil pressure switch to shut down compressor.
- C. Provide automatic capacity reduction equipment consisting of suction valve unloaders, and lifting mechanism operated by oil pressure gas discharge pressure solenoid valve centrifugal force. Provide for unloaded compressor start.
- D. Mount motor and compressor on one-piece ribbed cast iron or welded steel base with provision for V-belt adjustment.
- E. Provide thermostatically controlled water valve on compressor to maintain water temperature through compressor at 98°F to 109°F.

- F. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four-point; heavy-duty seismic-restrained California-approved isolation system for a minimum of 95% isolation efficiency. Engineering data shall be provided supporting isolation efficiency and equal weight distribution between supports. Pumps not having this feature shall have an inertia base sized for that system installed at this contractor's expense.

2.03 AIR RECEIVER

- A. Provide [_____] gallon [vertical] [horizontal] receiver, ASME stamped [125] [175] [250] [_____] psi working pressure. Receivers shall meet requirements of ASME Code for Unfired Pressure Vessels and bear ASME approval stamp. Flanged or screwed inlet and outlet connections.
- B. Fittings: Adjustable pressure regulator, safety valve, pressure gauge, drain cock, and automatic drain trap.
- C. Tank Finish: [Shop primed] [Hot-dipped galvanized] [Shop vinyl].

2.04 FILTER REGULATOR

- A. Push-pull, non-rising knob allows one-hand adjustment.
- B. Balanced valve-type diaphragm regulation ensures positive pressure adjustment.
- C. Regulator offers in-line repairability. Valve and diaphragm can be replaced without removing unit from line.
- D. Automatic drain.
- E. 10 psig minimum operating pressure.

2.05 CONTROLS

- A. Adjustable pressure switch set to cut out at 100 psi with minimum differential of 20 psi.

2.06 PIPING

- A. Design Pressure: 125 psi.
Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
 - 1. Pipe: Standard weight galvanized steel, threaded and coupled, ASTM A53.
 - 2. Joints: Screwed. (For below ground, all sizes to have welded joints, primed and painted.)
 - 3. Fittings: 150# steam 300# CWP, galvanized malleable iron, banded, ASTM A197, ANSI B16.3.
 - 4. Unions: 250# steam - 500# CWP, galvanized malleable iron, ANSI B16.39, ground joint with brass seat.
- C. Piping - 2-1/2" and Over:
 - 1. Pipe: Standard weight galvanized steel, beveled ends, ASTM A53.
 - 2. Joints: Butt welded and flanged. (All welded joints shall be ground, primed, and painted.)

3. Fittings: Standard weight seamless galvanized steel, butt weld type, ASTM A234, Grade WPB, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5.

D. Shutoff Valves:

1. Ball Valves:

- a. 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Acceptable Manufacturers: Apollo, Stockham, Milwaukee, Watts, Nibco, National Utilities Co., RUB.

NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

- b. 2-1/2" and 3", 150 psi saturated steam, 275 psi CWP ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Acceptable Manufactures: Apollo, Stockham, Nibco, Milwaukee.

NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

2. Plug Valves:

- a. 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port. Acceptable Manufactures: Walworth, DeZurik.
- b. 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port. Acceptable Manufactures: Walworth, DeZurik.
- c. 6" and larger, 125# steam @ 450°F, 175# CWP, cast iron body, flanged, resilient faced plug, gear and handwheel operator, full port. Acceptable Manufactures: Walworth, DeZurik.

E. Throttling Valves:

1. Globe Valves:

- a. 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Acceptable Manufactures: Crane, Stockham, Walworth, Milwaukee, Hammond, Watts, Nibco.
- b. 2-1/2" thru 10", 125# steam @ 450°F, 200# CWP @ 150°F, flanged, iron body, bronze mounted. Acceptable Manufactures: Crane, Hammond, Stockham, Walworth, Milwaukee, Watts, Nibco.

F. Check Valves:

1. 2" and under, 250# CWP, screwed, all iron, horizontal swing. Crane #346-1/2.
2. 2-1/2" thru 12", 125# steam @ 450°F, 200# CWP @ 150°F, flanged, all iron, horizontal swing. Acceptable Manufactures: Crane, Hammond, Stockham, Walworth, Milwaukee, Watts, Nibco.
3. 2" and larger, 125# CWP, flanged, iron body, cast iron or carbon steel body with stainless steel internals. Acceptable Manufactures: Hoerbiger Design "CT". NOTE: Use only for compressor discharge.

G. Strainers:

1. Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F. Acceptable Manufactures: Armstrong, Metraflex, Mueller Steam Specialty Co, Sarco, Watts.
2. Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F. Acceptable Manufactures: Armstrong, Metraflex, Mueller Steam Specialty Co., Sarco.

2.07 COMPRESSED AIR FILTERS

- A. Filters shall have a stainless steel sleeve, micro-glass media with epoxy coating, elastomeric filter to housing seal and sealed end caps.
- B. Filters shall be capable of removing the following:
 1. All solids 3 microns and larger.
 2. Liquids up to 25,000 ppm by weight.
 3. 99% of water droplets.
 4. 40% of oil aerosols.
- C. Provide a differential pressure alarm for each filter. Range shall be adjustable from 10 to 35 psi differential at 100 psig.
- D. Acceptable Manufacturer: Hankison.

2.08 COMPRESSED AIR CONDENSATE TRAPS

- A. Furnish and install traps of the type and capacity shown on the drawings.
- B. Traps shall be mechanically actuated with stainless steel construction, and 10-300 psig working pressure.
- C. Acceptable Manufacturer: Hankison.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

- A. All work to be furnished and installed under this section shall include but not necessarily be limited to the following:
 - 1. Electronic Water Softener
 - 2. Oil Interceptor
 - 3. Solids Interceptor
 - 4. Dilution Tank
 - 5. Grease Interceptor
 - 6. Lint Trap
 - 7. Drop inlets
 - 8. Curb inlets

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Plumbing Materials and Methods
- B. Section 221123: Pumps and Specialties
- C. Section 223400: Domestic Hot Water Heating Equipment
- D. Section 224000: Plumbing Fixtures

1.04 SUBMITTALS

- A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
 - 1. Oil Interceptor
 - 2. Solids Interceptor
 - 3. Dilution Tank
 - 4. Grease Interceptor
 - 5. Lint Trap

6. Water meters
 7. Drop inlets
 8. Curb inlets
- B. Electrical Work: Refer to Division 22, Section 220500 for requirements and coordinate with Division 26.
 - C. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
 - D. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, elevations, sections, and methods of assembly of components and anchorages.
 - E. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
 - F. Operation and Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 01. Submit operational manuals.
 - G. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
 - H. Start-up: Provide written report on start-up in accordance with Section 220500.
- 1.05 DELIVERY, STORAGE, AND HANDLING
- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
 - B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.
- 1.06 COORDINATION
- A. Coordinate size and location of concrete bases and attachments with structural design. Coordinate with Divisions 03 for specification of concrete, reinforcement and formwork requirements.
 - B. Coordinate the elevation and inverts of inlets and outlets of fixtures, elevation of building floor levels and elevation of upstream manhole covers as required by the Plumbing Code. Provide backwater valve in the building drain line or horizontal branch as required to protect fixtures where fixtures are located below the upstream manhole cover.
- 1.07 WARRANTY
- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
 - B. Refer to Division 1 for additional warranty and Substantial Completion requirements. Division 1 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

PART 2 PRODUCTS

2.01 ELECTRONIC WATER SOFTENER

- A. Provide electronic water treatment system to the following applications:
1. Incoming cold water line to the building and downstream of pumps.
 2. Incoming cold water line to the water heater system building and downstream of pumps.
 3. Entering water line to storage tanks and downstream of pumps.
 4. Discharge side of heat exchangers and downstream of pumps.
 5. Irrigation supply downstream of pumps.
- B. Provide and install in water distribution system(s) to reduce calcium hardness. System will not require the use of any chemicals or salts. Incoming water must have iron content of 10 ppb or greater to operate correctly to create nucleation seeds. Other means of water softening will be required where iron content is below 10 ppb.
- C. System shall include the following components:
1. Controller sized to treat water line sizes from 1" to 6". Controller shall be capable of interfacing with Building Automation System to provide remote monitoring of system operation and/or alarm. Controller transmits electrical pulses (1 kHz to 10 kHz) into the water in varying frequencies and amplitudes. These radio signals travel in both directions in the water piping and cause some of the minerals in the water to form sub-microscopic clusters which are carried in the water flow and not deposited on the walls in the piping system and equipment.
 2. Antenna propagation wiring shall be wrapped around piping as required by manufacturer. Wiring is wrapped around any pipe material and causes no reduction in water pressure. Pipe insulation can be installed over the wiring with no noticeable thickness or diameter increase in the pipe.
 3. 120 volt transformer with integral wiring to the controller. Maximum load of 0.1 amps. Power consumption to range from one (1) watt on smallest systems to three (3) watts continuous for largest systems. Provide dedicated receptacle and coordinate with electrical design.
 4. Refer to manufacturer for additional requirements and applications.
- D. Manufacturer: Aqua-Rex (www.aqua-rex.com) Series #WK1 through WK5, or approved equal.

2.02 GREASE INTERCEPTOR

- A. Grease traps to be constructed of duco coated steel. Provide with removal baffles and flow control.
- B. Provide with extensions for flush with floor installation and vent.
- C. Manufacturer: JR. Smith 8050, Zurn, or Wade.

2.03 GREASE INTERCEPTOR

- A. Grease interceptor to be constructed of concrete with two or three 24", minimum, clear access manholes with traffic weight frame and covers as required by local jurisdiction.

- B. Interceptor to be IAPMO listed and have a minimum of 2 components. See schedule for capacity.
- C. Features: HS-20 traffic rating, 6000 psi compressive strength, ceramic base coating for protection against low pH and microbial induced corrosion, unrestricted flow path.
- D. Provide sampling vault downstream of interceptor. Manufacturer: Oldcastle Precast #233-BL with cover.
- E. Manufacturer: Oldcastle Precast, or Jensen Precast.

2.04 GREASE INTERCEPTOR

- A. Grease separator shall be constructed of reinforced concrete according to the design, and with pre-fabricated internal parts and covers and as shown on the drawings.
- B. Separator: Furnish, construct, and install, as shown on plans, 1 Rockford Model GSC-20 reinforced concrete separator. Thickness of top and bottom shall be 12", and sides shall be of 8" reinforced concrete, with #4 reinforcing rods, 12" o.c. both ways, 6" hubbed inlet and outlet with outlet vent connection, and internal rear vent connection. Separator screen assembly shall be of 1/4" steel plate construction with removable filter screen and the necessary separator screen support frames. Initial shock plate shall be 1/4" steel plate.
- C. Inside dimensions of separator shall be 18'-0" long, 3'-6" wide, and 8'-0" deep, with 4 covers; 3/8" nonskid, diamond pattern, double section tread plate covers, fastened to cover support frames with recessed stainless steel bolts and suitable for pedestrian or light vehicular traffic.
- D. All supporting frames for separator screen assembly shall be anchored to inside walls of separator by means of 1/2" x 3" concrete anchor bolts. All internal support frames, shock plate, and separator screen assemblies shall be installed before top of separator is poured. All prefabricated assemblies shall have an acid resistant vinyl copolymer coating. An additional supply of protective coating shall be furnished to the contractor to be applied after installation of parts.
- E. Cover support frames shall be placed in proper position, and top of separator shall be poured around them. Inside and outside of concrete separator shall receive suitable waterproofing by contractor, and supplied by this manufacturer.
- F. Manufacturer: Rockford Sanitary Systems, Jensen Precast, or Oldcastle Precast.

2.05 GREASE INTERCEPTOR

- A. Molded high density polyethylene with minimum 3/8" uniform wall thickness. Interceptor shall be furnished for above or below grade installation, with field adjustable riser system, built-in flow control, built in test caps and three outlet directions. Cover shall provide water/gas tight seal with minimum 2,000 lbs. load capacity.
- B. Interceptor shall be built in accordance to ASME A112.14.3 (type C) and CSA B481.1,
- C. Manufacturer: Schier Great Basin Series.

2.06 GREASE INTERCEPTOR

- A. Molded high density polyethylene with minimum 3/4" uniform wall thickness. Interceptor shall be furnished for below grade installation, with field adjustable riser system. Cover shall provide water/gas tight seal and have minimum 16,000 lbs. load capacity.
- B. Sampling Port: Molded high density polyethylene with minimum 3/8" uniform wall thickness. Port shall be built in accordance with the Water Environment Federation's "Standard methods for Examination of Water and Wastewater" with sealed top access port and highway rated composite cover and TeleGlide™ field adjustable riser as required when buried.
- C. Flow Distributor: Flow splitter flow distributor, made of seamless, molded high density polyethylene with minimum 3/8" uniform wall thickness with sealed top access port and highway rated composite cover and field adjustable riser as required when buried.
- D. Manufacturer: Schier Big Foot Series.

2.07 LINT TRAP

- A. Lint separator as shown on drawings. Furnish and install all-welded steel separator with extension up to finished floor, hubbed, inlet and outlet with vent connection, internal vent connection, visible double wall outside trap seal, anchor flange without clamping ring, epoxy coating, anodes, sediment basket, reinforced cover for light traffic, secured with stainless steel bolts, heavy duty leak proof gasket, enamel coating inside, and bituminous coating outside.
- B. Manufacturer: Rockford #RLS Series.

2.08 OIL INTERCEPTOR

- A. Construction: Cast iron interceptor with acid resisting rubber base coating inside and out, double wall trap with cleanout, 2" vent connection, removable baffle, flow control fitting, gasketed cover, 3" inlet and 3" outlet. Provide with extension for flush mounting.
- B. Manufacturer: J.R. Smith 8550, or Zurn.

2.09 SOLIDS INTERCEPTOR

- A. Interceptor: 30 gpm, 3" outlet, 21" x 21" x 27" deep, 10 gauge steel with non-skid bolted top; coat interceptor exterior twice with Bitumastic.
- B. Manufacturer: Rockford #GFE.

2.10 DILUTION TANK

- A. Tank: 17" diameter x 31 1/2" high, high density polyethylene neutralization tank.
- B. Extension: 17" diameter high density polyethylene extension.
- C. Top Door: Circular loose lid bolt on and flange on 1" above finished floor.
- D. Provide 4" concrete pad under dilution tank.

2.11 CURB INLET

- A. Curb inlets shall be of the precast concrete type, as manufactured by Santa Rosa Cast Products or approved equal. The structure shall consist of a precast unit with three exterior walls, monolithically poured with a top slab. An opening shall be provided in the top slab for maintenance access and shall be 24-inch diameter minimum. The inlet side of the unit shall be provided with an integrally cast galvanized structural steel nosing. The access opening shall be trimmed with galvanized steel frame, cast integrally with the structure. A circular cover of reinforced concrete, trimmed with galvanized steel ring cast integrally with the cover, shall be constructed to fit the access opening. All steel nosings and frames shall be hot dipped galvanized after fabrication to requirements of ASTM specifications A123.

2.12 DROP INLET

- A. Drop inlets shall be of the precast concrete type as manufactured by Santa Rosa Cast Products Company, Santa Rosa, California, or approved equal. Concrete shall contain no less than 6 sacks of Type 2 cement per cubic yard and shall have a minimum compressive strength of 3,000 psi at 28 days. Wall thickness and reinforcing mesh shall be in accordance with the manufacturer's recommendations. All structures and grates in traffic areas shall be designed to withstand H-20 loading. Structural design of concrete reinforcement and grates shall be performed and approved by licensed civil engineer and shall take into consideration the intended loading and use. The precast units shall be constructed to conform to the design dimensions for each specific job, and shall be provided with pipe openings as per job requirements. Deflected pipe openings may be chipped by manufacturer in green concrete.
- B. Drop inlets exceeding four feet in depth may be poured in two or more units, and shall be provided with inter-locking keyed joints which shall be grouted with 1:4 mortar during installation. Two-inch diameter lifting holes shall be provided to facilitate job handling. Grates and frames shall be constructed of structural steel. Steel grates and frames shall be hot dipped galvanized after fabrication to requirements of ASTM specifications A123. All frames shall be integrally cast. The top surface of the drop inlet shall be finished smooth, shall be square and clean. Wall surfaces shall be formed, shall be flat and true to dimension.

PART 3 EXECUTION

3.01 GENERAL

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Orient so controls and devices needing service and maintenance have adequate access.
- D. Connect water piping to units with shutoff valves and unions as required for maintenance and system isolation.
- E. Start-Up: Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls. Start-up to be by authorized manufacturer's representative or agent.

3.02 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
 2. Leak Test: Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.
 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- 3.03 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES
- A. General: Refer to Section 220500 for requirements.

END OF SECTION

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SECTION 22 34 36

WATER HEATERS

PART 1 GENERAL

1.01 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. American Society of Mechanical Engineers:
 - 1. ASME PTC 25 - Pressure Relief Devices.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/ASME Section 8D - Pressure Vessels.
- E. ANSI Section 21.10.1 or Section ANSI 21.10.3 - Gas Water Heaters Ratings 75,000 BTU per Hour and Less.
- F. ANSI/NFPA 30 - Flammable and Combustible Liquids Code.
- G. ANSI/NFPA 54 - National Fuel Gas Code.
- H. ANSI/NFPA 70 - National Electrical Code.
- I. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.
- J. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.
- K. UL 174 - Household Electric Storage Tank Water Heaters.
- L. American National Standards Institute:
 - 1. ANSI Z21.10.1 - Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.
 - 2. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.
- M. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- N. American Society of Mechanical Engineers:
 - 1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- O. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.

1.02 REGULATORY REQUIREMENTS

- A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.
- B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.
- C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 PRODUCTS

2.01 GENERAL

- A. Type: Factory-assembled and wired, electric, vertical storage.
- B. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
- C. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
- D. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, and ASME rated temperature and pressure relief valve.
- E. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 Watts per square inch.
 - 1. Acceptable Manufacturers: Lochinvar, A.O. Smith, Bradford White, or Rheem.

2.02 WATER HEATER-ELECTRIC TANK TYPE

- A. Tank type electrical water heater with integral heating elements and insulated tank. Refer to drawings for locations, capacities, flow rates, power requirements and models.
- B. All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel. Tank shall be cathodically protected with adequate extruded magnesium anode. The entire vessel is to be enclosed in a round steel enclosure with baked enamel finish. Tank shall have a 150 psig working pressure. Foam insulated (R-16 minimum) tank to meet or exceed US DOE, ASHRAE/IESNA 90.1 and local energy code requirements.
- C. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. Factory wired for non-simultaneous operation. Set initial water heater temperature to 140°F (minimum).
- D. Heater shall include ASME pressure and temperature relief valve.
- E. Manufacturers: A.O. Smith, Bradford-White, Smith, American, Lochinvar, or Rheem.

2.03 WATER HEATER-ELECTRIC TANKLESS POINT-OF-USE TYPE

- A. Tankless point-of-use electric hot water heater for mounting adjacent to plumbing fixture(s). Flow rate features of water heater shall match the requirements for the connected lavatory faucets to provide a complete and workable system to all connected lavatories. Refer to drawings for locations, capacities, flow rates, power requirements and models.
- B. Features:
1. Enameled steel or aluminum housing.
 2. Copper and nickel chrome coils, insulated.
 3. Replaceable elements.
 4. Inlet water filter, replaceable.
 5. Maximum operating pressure: 150 psig.
 6. Single point power connection.
 7. Thermostatic control with adjustable temperature setpoint. Set initial water heater temperature to 110°F.
 8. High temperature limit switch, no pressure and temperature relief valve needed.
 9. Wall enclosure box for concealed installation in wall below sink(s). Provide all access doors and panels to enclose water heater in finished architectural surfaces. Frame of 16-gauge steel, door of 20-gauge steel, 1" flange width, continuous piano hinge, key or screw drive operated, prime coated. Manufacturer: Elmdoor/Stoneman #VB Series.
- C. For applications serving hot water to public-use lavatories:
1. Provide external or internal temperature mixing valve compliant with ASSE 1070 or CSA B125.3.
- D. Manufacturer: Chronomite #C-Micro Mix, Eemax, Bradford-White, In-Sink-Erator, or Hubbell.
- 2.04 WATER HEATER-ELECTRIC TANKLESS POINT-OF-USE TYPE FOR EMERGENCY SHOWER WITH EYE/FACE WASH
- A. Tankless point-of-use electric hot water heater for mounting adjacent to emergency shower with eye/face wash. Flow rate features of water heater shall match the requirements of the connected shower and/or eye/face wash. Refer to drawings for locations, capacities, flow rates, power requirements and models.
- B. Features:
1. Stainless steel or aluminum housing.
 2. Copper and nickel chrome coils, insulated.
 3. Replaceable elements.
 4. Maximum operating pressure: 150 psig.
 5. Single point power connection.
 6. Voltage/Phase: 480 V/3 ph
 7. Amperage: 139 amps (155 kW) minimum for 39°F rise at 20 gpm. Increase as necessary for entering domestic water temperatures below 50°F.
 8. Thermostatic control with adjustable temperature setpoint. Set initial water heater temperature to 84°F.
 9. High temperature limit switch, no pressure and temperature relief valve needed.

10. Provide temperature mixing valve compliant with ANSI Z358.1.

C. Manufacturer: Chronomite #ERB Series, or Eemax #Safeadvantage Series.

2.05 WATER HEATER-ELECTRIC AIR-TO-WATER HEAT PUMP TYPE

A. Electric air to water heat pump to be connected to external storage tank (specified separately). The heat pump removes heat and humidity from surrounding air and uses this to heat water. The refrigeration system produces cool, dehumidified air for local supplemental spot cooling. Refer to drawings for locations, capacities, flow rates, efficiency, power requirements and models. The heat pump water heater shall be packaged air source equipment, factory assembled, charged, and tested. The heat pump shall be suitable for heating potable water and have the capability of producing no less than 160°F (71°C) water, initially set to 140°F (60°C).

B. Heat Pump unit shall consist of compressor, condenser, evaporator coil, fan, hot water circulating pump, piping, and controls, factory assembled, charged, and tested. The heat pump shall contain the following components, and features:

- a. Cabinet: Shall use formed aluminum, or 304 or 316 Stainless Steel panels. Supports, channels and beams shall also be constructed of like material. Compartments shall have large access doors for servicing. Compressor and condenser shall be located in separate compartment from fan and evaporator for in operation servicing. Base section under evaporator coil shall have stainless steel drip pan for condensate. Cabinet shall be designed for outdoor operation. Cabinet shall be insulated to prevent condensation from forming on exterior surfaces. MERV-8, 2" thick air filters when distributing air to occupied areas. Supply and return air duct connections for using air in alternate locations.
- b. Fan: The fan arrangement shall be draw-through design. Fan shall be centrifugal, direct driven at no more than 1075 RPM. Blower scroll construction shall be 304 stainless steel with stainless steel fasteners. Blower wheel construction shall be galvanized steel or aluminum. Motor shall be foot mounted to blower scroll with stainless steel mount and fasteners, and vibration isolating rubber grommets.
- c. Evaporator Coil: Shall be constructed with aluminum waffle plate fins mechanically bonded to seamless copper tubing. All copper tube joints to be brazed with silver solder. Coils shall have aluminum coil casings and drain pan.
- d. Expansion Valve: Valves shall be specifically designed for heat pump use with field adjustable superheat feature. Expansion valve shall have MOP (Maximum Operating Pressure) type power element to effectively limit saturated suction temperature to 65°F (18°C).
- e. Compressor: Hermetic scroll type suitable for high temperature operation.
 - 1) Compressor controls/accessories must include the following:
 - (a) High and Low Refrigerant Pressure Safety Switches
 - (b) Indicator Lights for:
 - (1) Power On
 - (2) Hot Water Demand
 - (3) High Pressure Fail
 - (4) Low Pressure Fail
- f. Condenser: Stainless steel brazed plate vented double wall type. Single wall condenser construction shall not be allowed. UL Listed and suitable for high temperature operation with potable water.

- g. Refrigerant Accessories:
 - 1) Filter-Driers: Non-Replaceable Core type.
 - 2) Site Glass: Moisture indicating type.
- h. Anti-Short Cycle Control: Units shall be factory wired to allow a maximum of twelve compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize permitting the compressor to start in an unloaded condition.
- i. Water Circulating Pumps: Shall be in-line all bronze or stainless steel body centrifugal type able to deliver rated flow against the external head shown on the drawings.
- j. Controls: The heat pump unit shall be factory wired for fully automatic operation. Safeties shall include compressor and fan motor thermal overload protection, manual reset pressure stats, anti-cycling compressor relays, plus standard items recommended by the equipment manufacturer. Constant Leaving Water Temperature Control: Heat pump shall be factory equipped with electronic temperature control valve (e-TCV) which automatically maintains constant leaving water temperature (regardless of entering water temperature). Leaving water temperature is set by the heat pump operator/user via a field adjustable electronic temperature controller.

C. Manufacturer: Colmac Industries #HPA Series.

2.06 WATER HEATER-HYBRID ELECTRIC AIR-TO-WATER HEAT PUMP WITH ELECTRIC BACKUP AND INTEGRAL STORAGE

- A. Electric air to water heat pump with integral storage tank. The heat pump removes heat and humidity from surrounding air and uses this to heat water. The refrigeration system produces cool, dehumidified air for local supplemental spot cooling. Refer to drawings for locations, capacities, flow rates, efficiency, power requirements and models. The heat pump water heater shall be packaged air source equipment, factory assembled, charged, and tested. The heat pump shall be suitable for heating potable water and have the capability of producing no less than 140°F (60°C).
 - 1. Backup heat: Electric resistance
 - 2. Controls: Water heater shall be capable of operating in Efficiency, Hybrid or Electric only modes

B. Manufacturers: AO Smith, or Rheem

2.07 WATER HEATER-ELECTRIC WATER-TO-WATER HEAT PUMP TYPE

- A. The heat pump water heater shall be a packaged water source equipment, factory assembled and charged. The heat pump shall be suitable for heating potable water and have the capability of producing no less than 160°F (71°C) water, initially set to 140°F (60°C). Refer to drawings for locations, capacities, flow rates, efficiency, power requirements and models.
- B. Heat Pump unit shall consist of compressor, condenser, evaporator, hot water circulating pump, piping, and controls, factory piped and charged. The heat pump shall contain the following components, and features:
 - 1. Cabinet: Shall use formed aluminum, or 304 or 316 Stainless Steel panels. Supports, channels and beams shall also be constructed of like material. Compartments shall have large access doors for servicing. Cabinet shall be designed for outdoor operation.
 - 2. Evaporator: Shall be single-wall brazed plate type constructed with stainless steel plates.

3. Expansion Valve: Valves shall be specifically designed for heat pump use with field adjustable superheat feature. Expansion valve shall have MOP (Maximum Operating Pressure) type power element to effectively limit saturated suction temperature to 65°F (18°C).
 4. Compressor: Hermetic scroll type suitable for high temperature operation
 5. Compressor Controls: Compressor controls/accessories must include the following:
 - a. High and Low Refrigerant Pressure Safety Switches
 - b. Indicator Lights for:
 - 1) Power On
 - 2) Hot Water Demand
 - 3) High Pressure Fail
 - 4) Low Pressure Fail
 6. Condenser: Stainless steel brazed plate vented double wall type. Single wall condenser construction shall not be allowed. UL Listed and suitable for high temperature operation with potable water.
 7. Refrigerant Accessories:
 - a. Filter-driers: Non-Replaceable Core Type
 - b. Sight Glass: Moisture Indicating Type
 8. Anti-Short Cycle Control: Units shall be factory wired to allow a maximum of twelve compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize permitting the compressor to start in an unloaded condition.
 9. Hot Water Circulating Pumps: Shall be factory installed in-line all bronze or stainless steel body centrifugal type able to deliver rated flow against the external head shown on the drawings.
 10. Source Water Circulating Pumps: Provided by others. Refer to drawings pump(s) and flow capacity. Coordinate with heat pump manufacturer for pressure and flow requirements.
 11. Controls: The heat pump unit shall be factory wired for fully automatic operation. Safeties shall include compressor motor thermal overload protection, manual reset pressure stats, anti-cycling compressor relays, plus standard items recommended by the equipment manufacturer.
 12. Constant Leaving Water Temperature Control. Heat pump shall be factory equipped with electronic temperature control valve (e-TCV) which automatically maintains constant leaving water temperature regardless of entering water temperature. Leaving water temperature is set by the heat pump operator/user via a field adjustable electronic temperature controller.
- C. Manufacturer: A.O.Smith E-Tech #WW Series, or Colmac Industries #HPW Series.

2.08 DOMESTIC WATER EXPANSION TANK

- A. Precharged welded steel tank with air charging valve and removable heavy duty butyl/ EPDM diaphragm or bladder separating water and air with a working pressure of 150 psig. All internal parts shall comply with FDA regulations and approvals. The tank shall have NPT stainless steel connection, gauge glass openings and drain and be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. For model number see schedule on the drawings. Acceptable Manufacturers: Amtrol.

3.04 AQUASTATS

- A. Provide immersed type adjustable volatile liquid mercury tube switch similar to Mercoide Type DA-37-2 Range 5 (1 pole single), similar to Mercoide Type DA-37-127 Range 5 (2 pole duplex). Set in oversized tee and nipple in hot water return line for automatically controlling hot water circulators and hot water circulating pumps. Acceptable Manufacturers: Honeywell.

3.05 TIME SWITCH

- A. Provide an adjustable heavy duty self-starting synchronous motor clock (120 volt) in NEMA-1 enclosure for automatically controlling hot water circulators.
- B. Clock shall have seven-day calendar dial. Acceptable Manufacturers: Tork.

3.06 IN-LINE CIRCULATION PUMPS

- A. All bronze construction body, stainless steel face plate, 30% glass filled Noryl impeller, carbon steel shaft, stainless steel shaft sleeve, mechanical, carbon on silicon carbide seal, sealed precision steel ball bearing permanently lubricated motor bearings, maximum operating pressure of 150 psi; 1/12 HP, 115 volts, 2650 rpm, non-overloading type motor, drip-proof. Acceptable Manufacturers: Bell and Gossett, Grundfos, Taco.

END OF SECTION

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SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ASME A112.18.1 - Plumbing Fixture Fittings.
- C. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
- D. ASME A112.18.1 - Plumbing Fixture Fittings.
- E. ASME A112.18.2 – Plumbing Waste Fittings
- F. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
- G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- H. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
- I. ANSI Z358.1, "Emergency Eyewash and Shower Equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Wall Hung Fixture Carriers:
 - 1. Material: All Metal, ASME/ANSI A112.6.1M.
 - 2. Acceptable Manufacturers: Zurn, Smith, Wade, Josam, Watts, Mifab.
 - 3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.
- B. All china shall be from the same manufacturer where possible.
- C. All lavatory and sink trim shall be from the same manufacturer where possible.
- D. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

2.02 WATER CLOSET, FLOOR MOUNTED

- A. Bowl: ANSI A112.19.2M; 1.28 gallons per flush, commercial type, siphon jet, white vitreous china closet bowl with elongated rim, 1-1/2" spud and china bolt caps. Acceptable Manufacturers: American Standard, Kohler, Eljer.

- B. Flush Valve: ANSI A112.18.1; 1.28 gallons per flush, exposed chrome plated, diaphragm type with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, escutcheon, vacuum breaker, integral screwdriver stops. Acceptable Manufacturers: Sloan Model No. 110.
- C. Seat: Solid elongated white plastic, open front, stainless steel posts, and self-sustaining hinge. Acceptable Manufacturers: Church, Olsonite, Bemis.

2.03 WATER CLOSET, FLOOR MOUNTED, ACCESSIBLE

- A. Bowl: ANSI A112.19.2M; 1.28 gallon per flush, commercial type, siphon jet, white vitreous china closet bowl with elongated rim, 17" to 19" to top of seat, 1-1/2" top spud and china bolt caps. Acceptable Manufacturers: American Standard, Kohler, Eljer.
- B. Flush Valve: ANSI A112.18.1; 1.28 gallons per flush, exposed chrome plated, diaphragm with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, escutcheon, vacuum breaker, integral screwdriver stops. Acceptable Manufacturers: Sloan Model No. 110.
- C. Seat: Solid elongated white plastic, open front, stainless steel posts, and self-sustaining hinge. Acceptable Manufacturers: Church, Olsonite, Bemis.

2.04 WATER CLOSET, WALL HUNG

- A. Bowl: ANSI A112.19.2M; 1.28 gallons per flush, commercial type, siphon jet, white vitreous china closet bowl with elongated rim, 1-1/2" spud and china bolt caps. Acceptable Manufacturers: American Standard, Kohler, Eljer.
- B. Flush Valve: ANSI A112.19.2; 1.28 gallons per flush, exposed chrome plated, diaphragm type with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, escutcheon, vacuum breaker, integral screwdriver stops. Acceptable Manufacturers: Sloan Model No. 110.
- C. Seat: Solid elongated white plastic, open front, stainless steel posts, and self-sustaining hinge. Acceptable Manufacturers: Church, Olsonite, Bemis.

2.05 WATER CLOSET, WALL HUNG, ACCESSIBLE

- A. Bowl: ANSI A112.19.2M; 1.28 gallons per flush, commercial type, siphon jet, white vitreous china closet bowl with elongated rim, 17" to 19" to top of seat, 1-1/2" spud and china bolt caps. Acceptable Manufacturers: American Standard, Kohler, Eljer.
- B. Flush Valve: ANSI A112.19.2; 1.28 gallons per flush, exposed chrome plated, diaphragm with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, vacuum breaker, integral screwdriver stops. Acceptable Manufacturers: Sloan Model No. 110.
- C. Seat: Solid elongated white plastic, open front, stainless steel posts, and self-sustaining hinge. Acceptable Manufacturers: Church, Olsonite, Bemis.

2.06 WATER CLOSET, FLOOR MOUNTED, FLUSH TANK

- A. Bowl: ANSI A112.19.2M; 1.28 gallons per flush, pressure assisted, commercial type, siphon jet, white vitreous china closet with round front bowl, close-coupled tank and china bolt caps. Acceptable Manufacturers: American Standard, Kohler, Eljer.

- B. Seat: Solid white plastic, open front with stainless steel hinge posts. Acceptable Manufacturers: Church, Olsonite, Bemis.

2.07 URINAL, WALL HUNG

- A. Urinal: ANSI A112.19.2M; white vitreous china, 1/8 gallon per flush, commercial type, siphon jet with flushing rim, integral trap, and 3/4 inch top spud. Acceptable Manufacturers: American Standard, Kohler, Eljer.
- B. Flush Valve: ANSI A112.18.1; exposed chrome plated, diaphragm type with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, escutcheon, vacuum breaker. Acceptable Manufacturer: Sloan.
- C. Wall Mounted Carrier: ANSI A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.08 URINAL, WALL HUNG, ACCESSIBLE

- A. Urinal: ANSI A112.19.2M; white vitreous china, 1/8 gallon per flush, commercial type, siphon jet with flushing rim, integral trap, 17" to top of rim, 14" to 17" from wall to front of rim edge, and 3/4 inch top spud. Acceptable Manufacturers: American Standard, Kohler, Eljer.
- B. Flush Valve: ANSI A112.18.1; exposed chrome plated, diaphragm type with oscillating handle or hard wired infra-red sensor operated at the discretion of the campus, escutcheon, vacuum breaker. Acceptable Manufacturer: Sloan.
- C. Wall Mounted Carrier: ANSI A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.09 DRINKING FOUNTAIN

- A. Fountain: ASME A112.19.3; Wall mounted, 2 station, stainless steel, stain finish, push-button operation, laminar flow, lead free, polished chrome plated brass bubbler head, vandal-resistant bottom plate, integral 1 1/2" trap, less filter.
- B. Bottle Filling Station: A minimum of one (1) bottle filling/hydration station shall be provided within the project limits. , The bottle filler station may be supplied with the drinking fountain [with filter] or [without filter]. Acceptable Manufacturers: Elkay Model No. LVRCTLDDWSK
- C. Trim:
 - 1. Stops and Supplies: angle stops, lock shield type, 1/2", loose key, and flexible supplies. Acceptable Manufacturers for Stops: Chicago Faucet or Sloan. Acceptable Manufacturers for Supplies: Chicago Faucet, Brasscraft.

2.10 ELECTRIC WATER COOLER, ACCESSIBLE

- A. ASME A112.19.3; Wall mounted, dual "Hi-Lo" station, electric water cooler, 18 gauge, Type 304 stainless steel, , satin finish, push-button operated, polished chrome plated bubbler with stream guard, vandal resistant bubblers, vandal resistant strainers, vandal resistant bottom plates, louver intrusion resistant grill, mounting bracket, R-134 refrigerated with integral air cooled condenser; capacity of 8 gal/hr of 50 degree F water with inlet at 80 degree F, and room temperature of 90 degree F. Acceptable Manufacturers: Halsey Taylor, Haws, Elkay.
- B. Trim:

1. P-trap: 1 ¼" by 1 ½" chrome plated 17 gage cast brass, L.A. pattern, with secured escutcheon. Acceptable Manufacturers: McGuire.
2. Stops and Supplies: angle stops, lock shield type, 1/2", loose key, and flexible supplies. Acceptable Manufacturers for Stops: Chicago Faucet or Sloan. Acceptable Manufacturers for Supplies: Chicago Faucet, Brasscraft.

2.11 LAVATORY, ACCESSIBLE WALL HUNG

- A. Basin: ANSI A112.19.2M; vitreous china lavatory, approximately 20" x 18" rectangular basin, self-draining deck area, contoured splash shields, 4-inch high back, faucet ledge, 4-inch center drilling, front overflow, and concealed arm supports. Acceptable Manufacturers: American Standard and Kohler.
- B. Trim:
 1. Faucet: ANSI A112.18.1; chrome plated combination supply fitting with a cast brass body, adjustable time cycle, vandal resistant, with 0.35 gpm or 0.5 gpm aerator, manual metered faucet. Adjust between 10 and 15 seconds. Acceptable Manufacturers: Chicago Model No. 333-665E39PSHABCP or Chicago Model No. 3400-ABCP.
 2. P-trap: 1 ¼" by 1 ½" chrome plated 17 gage cast brass, L.A. pattern, with secured escutcheon. Acceptable Manufacturers: McGuire.
 3. Drain: ANSI/ASME A112.18.2, chrome plated, brass construction, open grid strainer, 1 ¼" tailpiece. Acceptable Manufacturers: Chicago Faucet, Elkay.
 4. Stops and Supplies: angle stops, lock shield type, 3/8", loose key, and flexible supplies. Acceptable Manufacturers: Chicago Faucet, Brasscraft.

2.12 LAVATORY, ACCESSIBLE COUNTER TOP

- A. Basin: ANSI A112.19.2M; vitreous china, approximately 20" x 17" oval basin, self-rimming, faucet ledge, 4-inch center drilling with front overflow. Acceptable Manufacturers: American Standard, Kohler.
- B. Trim:
 1. Faucet: ANSI A112.18.1; chrome plated combination supply fitting with a cast brass body, adjustable time cycle, vandal resistant, with 0.35 gpm or 0.5 gpm aerator, manual metered faucet. Adjust between 10 and 15 seconds. Acceptable Manufacturers: Chicago Model No. 333-665E39PSHABCP or Chicago Model No. 3400-ABCP.
 2. P-trap: 1 ¼" by 1 ½" chrome plated 17 gage cast brass, L.A. pattern with secured escutcheon. Acceptable Manufacturers: McGuire.
 3. Drain: chrome plated, brass construction, open grid strainer, 1 ¼" tailpiece. Acceptable Manufacturers: Chicago Faucet, Elkay.
 4. Stops and Supplies: angle stops, lock shield type, 3/8", loose key, and flexible supplies. Acceptable Manufacturers: Chicago Faucet, Brasscraft.

2.13 SINK, ACCESSIBLE SINGLE COMPARTMENT

- A. Bowl: ANSI A112.19.3; outside dimension approximately 20" x 19", 5-inch deep outside dimensions, 18 gage thick, Type 304 stainless steel, self-rimming with undercoating, single hole punching, 3-1/2 inch strainer, ledge back drilled for trim. Acceptable Manufacturers: Elkay, Just.
- B. Trim:

1. Faucet: ANSI A112.18.1; deck mounted, gooseneck spout, chrome plated with a cast brass body, vandal resistant, with 1.5 gpm aerator, manually operated sensor. Acceptable Manufacturers: Chicago Faucet.
2. P-trap: 1 ½" chrome plated 17 gage cast brass, L.A. pattern with secured escutcheon. Acceptable Manufacturers: McGuire.
3. Drain: 3-1/2", Type 304 stainless steel, basket strainer, 1 1/2" tailpiece. Acceptable Manufacturers: Chicago Faucet, Just, Elkay.
4. Stops and Supplies: angle stops, lock shield type, 3/8", loose key, and flexible supplies. Acceptable Manufacturers: Chicago Faucet, Brasscraft.

2.14 SINK, ACCESSIBLE DOUBLE COMPARTMENT

- A. Bowl: ANSI A112.19.3; 19" x 33" x 5-inch deep, 18 gage thick, Type 304 stainless steel, self-rimming with undercoating, three hole punching, 3-1/2 inch strainer on left bowl, ledgeback drilled for trim, disposer under right bowl. Acceptable Manufacturers: Elkay, Just.
- B. Trim:
 1. Faucet: ANSI A112.18.1; deck mounted, gooseneck spout, chrome plated with a cast brass body, vandal resistant, with 1.5 gpm aerator, manually operated sensor. Acceptable Manufacturers; Chicago Faucet.
 2. P-trap: 1 ½" chrome plated 17 gage cast brass, L.A. pattern with secured escutcheon. Acceptable Manufacturers: McGuire.
 3. Drain: 3-1/2", Type 304 stainless steel, basket strainer, 1 1/2" tailpiece. Acceptable Manufacturers: Chicago Faucet, Just, Elkay.
 4. Stops and Supplies: angle stops, lock shield type, 3/8", loose key, and flexible supplies. Acceptable Manufacturers: Chicago Faucet, Brasscraft.

2.15 INSULATION KIT

- A. Where lavatories or sinks are noted to be insulated for ADA compliance, furnish the following: Safety covers conforming to ANSI A177.1, ASTM E84-07 and consisting of insulation kit of molded closet cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves and supply piping. Acceptable Manufacturers: Truebro.

2.16 MOP SINK, FLOOR MOUNTED

- A. Bowl: Enameled cast iron, corner type, with 3" IPS drain and flat chrome grid strainer and vinyl rim guard. Acceptable Manufacturers; American Standard, Kohler, CECO
- B. Trim: ANSI A112.18.1; wall mounted, lever handles, chrome plated, integral check valves, integral stop valves with vacuum breaker, pail hook and 3/4"-inch hose thread outlet. Acceptable Manufacturers; Chicago Faucet.

2.17 COMBINATION EMERGENCY SHOWER AND EYE/FACE WASH

- A. Barrier-free design with coated galvanized steel piping; ANSI Z358.1 compliant, impact-resistant plastic shower head, Chrome-plated brass 1 1/4 inch IPS stay-open ball-type shower valve operated by a 304 stainless steel pull rod having triangular handle, 304 stainless steel eye wash bowl, [chrome-plated brass] [ABS plastic] spray head assembly eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, [PVC] [304 stainless steel] [push handle] [foot pedal], and 1-1/4 inch water supply connection.
- B. Acceptable Manufacturers: Haws, Bradley, Guardian.

2.18 EYE/FACE WASH - WALL MOUNTED:

- A. Barrier-free design ANSI Z358.1 compliant, with stainless steel bowl; stainless steel wrap-around skirt; chrome-plated brass spray head assembly with twin, soft flow, eye wash heads and protective spray head covers; integral flow control capable of maintaining uniform flow under varying water supply conditions from 30-90 psig; Chrome-plated 1/2 inch IPS stay-open ball-type eye wash valve hand operated by a large, stainless steel push handle; chrome-plated circular face spray ring; chrome plated brass pipe and fittings; dome type strainer; 1-1/4 inch drain fitting, wall tube and trap; universal identification sign; inspection tag, and 1/2 inch water supply connection.
- B. Acceptable Manufacturers: Haws, Bradley, Guardian.

2.19 EMERGENCY THERMOSTATIC MIXING VALVE:

- A. ANSI Z358.1 compliant, ASSE 1071 Certified, Lead Free, Liquid-filled thermostat or bimetallic thermostat, Strainer checkstops on inlets, adjustable temperature set point, built-in cold water bypass, positive shutoff of hot supply when cold supply is lost, dial thermometer, brass construction.
- B. Acceptable Manufacturers: Bradley, Leonard.

2.20 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
 1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
 2. Insulated at accessible lavatories and sinks.
 3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
 4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.

2.21 TRAP SEALS AND PRIMERS

- A. Trap primers shall be pressure drop activated and be of all brass construction including a brass body with ½-inch male NPT inlet and ½-inch female NPT discharge. Internal components shall consist of a stainless steel debris screen, brass piston and brass discharge jet. Lubricated O-rings shall be EPDM and seal O-rings shall be nitrile. The trap primer shall be designed to operate upon a drop in line pressure of 10 psi. Working pressure shall be 35psi to 75 psi and a working temperature range of range of -40° to 450°F. Valves shall be listed with ASSE 1018. Acceptable Manufacturers: Precision Plumbing Products, Watts, Sioux Chief.
- B. Trap primer enclosed in a NEMA-1 enclosure, flush mounted box, with a ½-inch NPT female inlet complying with ANSI/ASME B1.20.1, outlet shall be ½-inch compression fitting, with a 5/8-inch Type "L" copper tubing manifold complying with ASTM B88, provide with circuit breaker, switch, timer, manual override, solenoid valve marked as UL Listed, electronic assembly tested and certified per UL #73, and backflow device anti-siphon atmospheric vacuum breaker meets IAPMO, ASSE 1001 and CSA. Unit shall comply with ASSE Standard No. 1018. Working pressure shall be 35psi to 75 psi and a working temperature range of range of -40°F to 450°F. Acceptable Manufacturers: Precision Plumbing Products, Sioux Chief, Zurn.

2.22 WATER HAMMER ARRESTORS:

- A. Water hammer constructed of type K hard drawn copper, cap attached by 95-5 solder joint, piston and threaded adapter of machined brass, "O"-ring constructed in compliance with EP-5778-80, silicon seal lubricant, operating pressures of 35 to 250 psi, spike pressures of 1,500 psi, temperature range -40°F to 212°F. Acceptable Manufacturers: Precision Plumbing Products, Watts, Sioux Chief.

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DIVISION 23
HEATING, VENTILATING, AND AIR-CONDITIONING
(HVAC)

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SECTION 23 05 00

BASIC HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE OF THIS SECTION

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Compliance with all codes and standards applicable to this jurisdiction
 - 2. Shop Drawings for Equipment
 - 3. Coordination Documents
 - 4. Record Drawings
 - 5. Start-up Service and Building Commissioning
 - 6. Instruction, Maintenance, and O & M Manuals
 - 7. Work associated with Delivery, Storage, and Handling of products
 - 8. Work associated with provision of Temporary Facilities
 - 9. Preparation of Posted Operating Instructions
 - 10. Meeting Project Safety and Indemnity requirements
 - 11. Proper Cleaning and Closing
 - 12. Supplying proper Warranty information
 - 13. Supply specified Guarantee documentation
 - 14. Design and provision of Supports and Anchors
 - 15. Pipe Portals
 - 16. Pipe Supports
 - 17. Equipment Rails
 - 18. Access Doors
 - 19. Identification Markers
 - 20. Coordination of Electrical requirements for equipment provided

1.03 DESCRIPTION OF WORK

- A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.

- B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate this work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.
- C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.
- D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.
- E. The contractor shall design and supply all miscellaneous metals and system support components that are necessary to support all mechanical system, whether indicated or not on the drawings. Such metals and support components and related connections shall be provided as necessary to directly and concentrically impose loads on the primary structure. Refer to structural design requirements for specific attachment requirements. The mechanical system supports shall accommodate lateral movements between floors as defined in the story drift requirements.
- F. The contractor shall design and supply mechanical devices and system components that are necessary to accommodate structural movement as defined by structural design criteria associated with ductwork and piping transitions through building expansion joints. Design of expansion joints to allow for dimensional changes in portions of a structure separated by such joints should take both reversible and irreversible movements into account.

1.04 DESCRIPTION OF BID DOCUMENTS

- A. Specifications:
 - 1. Specifications, in general, describe quality and character of materials and equipment.
 - 2. Specifications are of simplified form and include incomplete sentences.
- B. Drawings:
 - 1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
 - 2. Before proceeding with work check and verify all dimensions.
 - 3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
 - 4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
 - 5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
 - 6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative interpretation and decision as early as possible, including during bidding period.

1.05 DEFINITIONS

- A. Above Grade: Not buried in the ground and not embedded in concrete slab on ground.
- B. Accessible: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.
- C. Actuating or Control Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
- D. Below Grade: Buried in the ground or embedded in concrete slab on ground.
- E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
- F. Connect: Complete hook-up of item with required service.
- G. Drift: The horizontal deflection at the top of the story relative to the bottom of the story. Refer to structural design for drift dimensional movements.
- H. Expansion Joint: A mid-structure separation designed to relieve stress on building materials caused by building movement induced by any of the following: thermal expansion and contraction; wind sway; seismic events; static load deflection; or live load deflection. Expansion joint systems are used to bridge the gap and maintain building assembly functions while accommodating expected movements. Expansion joints also include transitions from an existing building to a new building addition. Refer to structural design for expansion joint dimensional movements.
- I. Explosion Proof Equipment (per National Electrical Code-Article 501): Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. Explosion proof motors are required for Class I, II or III applications regardless of Division or Group as defined in National Electrical Code – Article 501 and ANSI/ISA-12.20.01.
 - 1. Class I: Hazardous due to flammable gases or vapors are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
 - 2. Class II: Hazardous due to combustible or conductive dusts are present or may be present in quantities sufficient to produce explosive or ignitable mixture.
 - 3. Class III: Hazardous due to ignitable fibers are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
 - 4. Division: The substance referred to by Class has a high probability (Division 1) or low probability (Division 2) of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.
 - 5. Group: Type of hazardous material in surrounding environment ranging from Group A flammable liquids to Group G combustible dusts.
- J. Exposed: Not installed underground or concealed.
- K. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.

- L. Furnish: To supply equipment and products as specified.
- M. Indicated, Shown or Noted: As indicated, shown or noted on Drawings or Specifications.
- N. Install: To erect, mount and connect complete with related accessories.
- O. Motor Controllers: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
- P. Must: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall.
- Q. Noncombustible Material: A noncombustible material is a substance that will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat in compliance with ASTM E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C. Examples of noncombustible materials include the following, but confirm compliance in manufacturer literature:
 - 1. Portland cement concrete, concrete, gypsum concrete (normally used in drywall or poured gypsum floor toppings), Portland cement stucco, Portland cement plaster, and gypsum plaster, gypsum wall board (sheetrock), and Type X gypsum wall board.
 - 2. Brick masonry, concrete block masonry, and ceramic tiles.
 - 3. Steel, stainless steel, galvanized steel, and other metals, except aluminum (aluminum is classified as limited-combustible), magnesium and magnesium alloys.
 - 4. Sheet glass, block glass, and uncoated glass fibers.
 - 5. Mineral wool and rock wool.
- R. NRTL: Nationally Recognized Testing Laboratory, including UL and/or ETL.
- S. Piping: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- T. Provide: To supply, install and connect as specified for a complete, safe and operationally ready system.
- U. Reviewed, Satisfactory or Directed: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner's Representative.
- V. Rough-In: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
- W. Shall: An exhortation or command to complete the specified task including providing and installing work associated with task.
- X. Similar or Equal: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
- Y. Supply: To purchase, procure, acquire and deliver complete with related accessories.
- Z. Typical or Type: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

- AA. Will: A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall".
- BB. Wiring: Raceway, fittings, wire, boxes and related items.
- CC. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.06 RELATED WORK SPECIFIED ELSEWHERE

- A. All Division 23 Mechanical sections included herein.
- B. Division 33: Utility Site Work.
 - 1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.
- C. Division 03: Concrete.
 - 1. All concrete work required for mechanical work shall be coordinated by Division 23 with Division 03 including:
 - a. Concrete curbs and housekeeping pads for the mechanical equipment.
 - b. Thrust blocks, pads, and boxes for mechanical equipment.
- D. Division 07: Thermal and Moisture Protection.
 - 1. Flashing and sheet metal.
 - 2. Sealants and caulking.
 - 3. Firestopping.
- E. Division 09: Painting.
 - 1. Division 23 shall coordinate with Division 09 to perform all painting, except where specifically stated otherwise in Division 09.
 - 2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials
- F. Division 10: Miscellaneous Metals.
 - 1. Exterior louvers and grilles shall be included in this Section.
- G. Division 26: Electrical.
 - 1. Power connections to all mechanical equipment
- H. Division 28: Electronic Safety and Security.
 - 1. Fire protection alarms and relays.
 - 2. Smoke detector and monitoring.
 - 3. Life safety systems.

1.07 CODES AND STANDARDS

- A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

- B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.
- C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.
- D. All accessible mechanical work shall comply with the minimum requirements of the Americans with Disabilities Act (ADA) and local amendments. Also, refer to ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities. Refer to Architectural drawings and specifications for additional ADA requirements. The following requirements are provided as consolidated list of minimum ADA requirements. Compliance requirements applicable to HVAC work includes, but is not limited to, the following:
 - 1. Section 309: Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds maximum.
 - 2. Section 308.3: Temperature control devices mounted on walls with operable buttons or switches shall be placed where clear floor or ground space allows a parallel approach and the side reach is unobstructed. Operable parts shall be located 48" maximum above finished floor, and no lower than 42" above finished floor. Do not mount above light switches to avoid inaccurate temperature readings due to light switch heat output.
 - 3. Section 308.3.2: Where a clear floor or ground space allows a parallel approach to an element and high reach is over an obstruction, the height of the obstruction shall be 34" maximum and depth of obstruction shall be 24" maximum.
 - 4. Section 404.2.9: Fire doors shall have a minimum opening force allowable by the applicable Building Code. The force for pushing or pulling open a door other than fire doors shall be 5 pounds maximum.
- E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
- F. Provide in accordance with rules and regulations of the following:
 - 1. California Building Codes enforced by the Authority Having Jurisdiction (AHJ):
 - a. 2022 Building Standards Administrative Code, Part 1, Title 24 California Code of Regulations (CCR).
 - b. 2022 California Building Code (CBC), Part 2, Title 24 CCR (2021 International Building Code with California Amendments).
 - c. 2022 California Electrical Code (CEC), Part 3, Title 24 CCR (2020 National Electrical Code with California Amendments).
 - d. 2022 California Mechanical Code (CMC) Part 4, Title 24 CCR (2021 Uniform Mechanical Code with California Amendments).
 - e. 2022 California Plumbing Code (CPC), Part 5, Title 24 CCR (2021 Uniform Plumbing Code with California Amendments).
 - f. 2022 California Energy Code (CEC), Part 6, Title 24 CCR.
 - g. 2022 California Fire Code, Part 9, Title 24 CCR (2021 International Fire Code with California Amendments).
 - h. 2022 California Green Building Standards Code (CALGreen), Part 11, Title 24 CCR.

- i. 2022 California Referenced Standards, Part 12, Title 24 CCR.
 - j. Title 19 CCR Public Safety, State Fire Marshal Regulations.
 2. Local, city, county and state codes and ordinances.
 3. Local Bureau of Buildings.
 4. Local Health Department.
 5. Local and State Fire Prevention Districts.
 6. State Administrative Codes.
- G. Provide in accordance with appropriate referenced standards of the following and as referenced in other specification sections:
 1. AABC - Associated Air Balance Council
 2. ADA - Americans with Disabilities Act
 3. ADC - Air Diffuser Council
 4. AHRI - Air Conditioning, Heating and Refrigeration Institute
 5. AMCA - Air Moving and Conditioning Association
 6. ANSI - American National Standards Institute
 7. ASCE 7-10 – American Society of Civil Engineers – Minimum Design Loads for Buildings and Other Structures
 8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
 9. ASME - American Society of Mechanical Engineers
 10. ASTM - American Society for Testing Materials
 11. AWS - American Welding Society
 12. CSA - Canadian Standards Association
 13. ETL - Electrical Testing Laboratories
 14. FM - Factory Mutual
 15. IBC - International Building Code
 16. ICC AC156 Seismic Certification by Shake-Table Testing of Nonstructural Components.
 17. MSS - Manufacturer's Standardization Society
 18. NEMA - National Electrical Manufacturer's Association
 19. NFPA - National Fire Protection Association
 20. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
 21. UL - Underwriter's Laboratories
- H. Provide compliance in accordance with the following referenced standard which applies to general system compliance in contrast to specific equipment standards referenced elsewhere:
 1. UL-2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces. This is applicable to spaces above suspended ceilings and below raised floors.

1.08 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Owner's Representative for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Owner's Representative for a decision before proceeding.

1.09 QUALITY ASSURANCE

- A. Manufacturer's Nameplates: Nameplates on manufactured items shall be metallic riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data suitable for the ambient exposure.
- B. All work shall include the following:
 - 1. Manufactured items and equipment shall be a current, cataloged product of the manufacturer.
 - 2. Replacement parts shall be readily available and stocked in the USA.
- C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.
- D. Each product and/or equipment type shall be provided by one manufacturer. Mixtures of manufacturers for each product and/or equipment type are not acceptable. Example – all fire dampers shall be supplied by one manufacturer.
- E. Special Inspections: Provide structural design and Special Inspections as required in Chapter 17 of the local building code and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.
- F. Welding Standards:
 - 1. Welding Qualifications:
 - a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The welder must maintain their certification to show qualified welding experience every six months. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.
 - 2. Welding Procedures:
 - a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.

- b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

G. Pressure Piping Standards

- a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
- b. Comply with ASME B31.9 Building Services Piping standard for the following services:
 - 1) Conveying fluid between 0°F (-18°C) to 250°F (121°C).
 - 2) Fluid pressure less than 350 psig.
- c. Comply with ASME B31.1 Power Piping standard for the following services:
 - 1) Steam.
- d. Comply with ASME B31.3 Process Piping standard for the following services:
 - 1) Conveying fluid above 250°F (121°C).
 - 2) Toxic or flammable fluids.

1.10 GENERAL REQUIREMENTS

- A. Examine all existing conditions at building site.
- B. Review contract documents and technical specifications for extent of new work to be provided.
- C. Provide and pay for all permit, licenses, fees and inspections, including, but not limited to, building permits, planning permits, air quality management district permits, operating licenses, utility district fees, special district fees, environmental impact reports, and additional local permits and fees.
- D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 23 31 13 - Air Distribution for a summary of requirements.
- E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access. Joints and fittings shall not be located in inaccessible locations such wall, floor and roof penetrations.
- F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications for rough-in requirements.
- G. Coordinate mechanical equipment and materials installation with other building components.
- H. Ductwork and piping dimensions, as identified on drawings and in specifications, refer to the interior free dimensions. Adjust work as necessary to account for larger outside dimensions to account for material wall thickness. Upsize plastic pipe diameters as necessary to maintain minimum interior dimensions.

- I. Verify all dimensions by field measurements.
- J. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- K. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- L. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- M. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor shall provide for all cutting and patching required for installation of this work unless otherwise noted.
- N. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- O. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.
- P. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
- Q. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- R. Coordinate with Owner's Representative in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.
- S. All materials (such as supports, gaskets, sealants, insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall be noncombustible or have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Coordinate with all disciplines to assure that all discrete electrical, plumbing and mechanical products located in plenums are non-combustible and compliant with UL 2043.
- T. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.
- U. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.11 MINOR DEVIATIONS

- A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.
- B. The Contractor shall review the structural and architectural conditions affecting their work. It is the specific intention of this section that the contractor's scope of work shall include:
- C. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
- D. Minor deviations from the mechanical plans required by architectural and structural coordination.
- E. The Contractor shall study the operational requirements of each system, and shall arrange work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work". Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.
- F. Minor deviations to avoid conflict shall be permitted where the design intent is not altered.
- G. Advise the Owner's Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner's Representative of conflict.

1.12 SPECIFIED EQUIPMENT

- A. Where specific manufacturers and/or model numbers are provided in the contract documents, it shall be understood that they constitute the design basis for the project. Where approved optional manufacturers are identified, the Contractor may submit based on these manufacturers, however, the submittals must be inclusive of all additional costs (or credits) and coordination requirements necessary to successfully and fully implement said manufacturer's product. See section on Substitutions below for procedures to use non-specified equipment.
- B. **Where required by law**, specified equipment listed on the contract documents shall be interpreted to include the phrase "or equal" to allow products that are equal to those specified. The Engineer of Record has the sole authority to accept a product as equal to the specified product. For an "or equal" product to be accepted for use on the project, the following conditions must be met:
 - 1. The proposed "or equal" substitution shall be submitted within seven days (7) of contract award.
 - 2. Contractor shall notify the Engineer as to how the substituted product will impact the project completion.
 - 3. Contractor shall notify Engineer as to the costs of both the substituted product and the listed product.
 - 4. Contractor shall provide a detailed analysis of the difference between the listed product and proposed product.
 - 5. Contractor shall provide:
 - a. Product identification, manufacturer literature, samples, names and addresses of similar projects where the substituted product has been used along with facility contact information, and

- b. The name and address of the manufacturer's representative
- 6. Contractor shall pay the cost of the design team to review the proposed substitution and any redesign fees.
- C. Engineer's approval of an "or equal" product does not relieve Contractor of the responsibility to submit required shop drawings and to comply with all other requirements of the Contract Documents.

1.13 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
- B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Owner's Representative for approval.
- C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.
- D. Delegated-Design Submittal: For structural pipe and equipment supports, vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic, and where required wind forces required to select vibration isolators, seismic and wind restrains, support framing members, and for designing vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.
- E. Submittals and Shop Drawings:
 - 1. Submit electronic copies of manufacturer's submittal sheets in one (1) coordinated package per Division. Multiple submissions will not be accepted without prior approval of the Owner's Representative. Organize submittal sheets in sequential order aligned with matching specification section numbers.
 - 2. Provide electronic copies of shop drawings prepared to show details of the proposed installation. Copies of contract design drawings submitted to demonstrate shop drawing compliance will not be accepted.
 - 3. Paper submittals will only be acceptable if specifically required by Division 01.
 - 4. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.14 COORDINATION DOCUMENTS/SHOP DRAWINGS

- A. The Contractor shall prepare coordinated Shop Drawings using the same electronic format as the contract documents.

1. The shop drawings shall serve to record the coordination of the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances.
 2. The Drawings shall include all mechanical rooms and floor plans.
 3. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Owner's Representative and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor and Owner's Representative.
 4. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.
- B. The coordination work shall be prepared as follows:
1. Two dimensional AutoCAD / Revit based documents:
 - a. Contractor shall prepare AutoCAD/Revit coordination drawings to an accurate scale of 1/4" = 1'-0" or larger. Drawings are to be same size as Contract Drawings and shall indicate locations, sizes and elevations above finished floor, of all systems. Lettering shall be minimum 1/8" high.
 - b. Contractor shall obtain AutoCAD/Revit drawings from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the HVAC work.
 - c. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
 - d. Drawings shall incorporate all addenda items and change orders.
 - e. Distribute drawings to all other trades and provide additional coordination as needed to assure adequate space for piping, equipment and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.
 2. Three dimensional Revit / BIM based documents (if required for project):
 - a. Provide three dimensional Revit model and BIM input information locating all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
 - b. Contractor shall obtain Revit model and BIM input from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
 - c. Model shall indicate locations of all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
 - d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.

- e. Model shall incorporate all addenda items and change orders.
 - f. Distribute Revit model and BIM input information to all other trades and provide additional coordination as needed to assure adequate space for equipment and piping and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.
- C. Advise the Owner's Representative in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner's Representative of conflict.
- D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owner's Representative of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.
- E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.
- F. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.15 REQUESTS FOR INFORMATION (RFIS)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 01).
- 1. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
 - 2. RFIs shall address single questions and related issues only.
 - 3. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to the Owner's Design Representative.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
- 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Contractor.
 - 5. Name of Architect and/or Construction Manager.
 - 6. RFI number, numbered sequentially and unique.
 - 7. RFI subject.
 - 8. Specification Section number and title and related paragraphs, as appropriate.
 - 9. Drawing number and detail references, as appropriate.
 - 10. Field dimensions and conditions, as appropriate.
 - 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response to each RFI, plus additional time for Architect and General Contractor to review and forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following business day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Incomplete RFIs or inaccurately prepared RFIs.
 - b. RFIs submitted without indication of review and approval for submission by General Contractor or Construction Manager.
 - c. RFIs addressing multiple unrelated issues.
 - d. Requests for approval of submittals.
 - e. Requests for approval of substitutions.
 - f. Requests for approval of Contractor's means and methods.
 - g. Requests for information already indicated in the Contract Documents.
 - h. Requests for adjustments in the Contract Time or the Contract Sum.
 - i. Requests for interpretation of Engineer's actions on submittals.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

1.16 RECORD DOCUMENTS

- A. Maintain set of Coordination Documents (drawings and specifications) marked "Record Set" at the job site at all times and use it for no other purpose but to record on it all the changes and revisions during construction.
- B. Record Drawings shall indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.).
- C. Record Specifications shall indicate approved substitutions; Change Orders; and actual equipment and materials provided.
- D. Provide copy of Record Documents to Testing and Balancing Contractor and Commissioning Agent for use when performing their work.
- E. At the completion of the construction transfer all "Record Set" notations to a clean set of drawings and specifications in a neat and orderly fashion that incorporates all site markups to clearly show all changes and revisions to the Contract Documents. Submit copies of Record Documents and CD/DVD disks labeled with all drawings and specifications and other supporting documentation.

- F. Refer also to Division 01 for full scope of requirements.

1.17 START-UP SERVICE AND BUILDING COMMISSIONING

- A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.
- B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.
- C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.
- D. Refer to other Division 23 Sections for additional requirements.

1.18 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

- A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Owner's Representative complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.
- B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23. Training is to be appropriate to the complexity of the equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.19 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping and equipment showing signs of rust shall be removed from site and replaced with new.

1.20 UNIT PRICING SUBMITTALS

- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
- B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to Owner's Representative for preliminary approval a complete list of manufacturer's names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
 - 1. Indicate substituted items.

2. Identify test and balancing agency.
 3. Identify independent testing laboratory for water analysis.
- C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.
- D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.21 TEMPORARY FACILITIES

- A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary heating, air conditioning, ventilation, water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.
- B. Temporary Heating for Commissioning Tests:
1. Provide temporary heating where needed to provide false load for commissioning tests.
 2. Temporary heating may be from the permanent heating system of the project or from a dedicated temporary heating system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon what work in place or being installed.
- C. Temporary Cooling for Commissioning Tests:
1. Provide temporary cooling where needed to provide false load for commissioning tests.
 2. Temporary cooling may be from the permanent cooling system of the project or from a dedicated temporary cooling system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon the work in place or being installed.

1.22 POSTED OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.23 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.
- B. No act, service, Drawing, review, or Construction Review by the Owner's Representative, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

- C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner's Representative, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.24 CLEANING AND CLOSING

- A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
- B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Owner's Representative.

1.25 WARRANTIES

- A. Refer to general terms and conditions, as well as warranties and obligations defined in Division 1 of the specifications that provide basic warranty requirements for the entire project.
- B. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.
- C. All equipment and systems shall be provided with a minimum one-year warranty, or longer, as defined in each subsequent specification section. Warranty shall include all parts, material, labor and travel.
- D. Warranty Start Date: The start date for all warranty periods shall be defined as starting from the date of Substantial Completion which shall include the Certificate of Occupancy from the Authority Having Jurisdiction.
- E. Refer to individual Specification sections for additional extended warranty requirements.
- F. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
- G. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.
- H. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.26 GUARANTEE

- A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year, minimum, after Substantial Completion, ordinary wear and tear excepted.
- B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

PART 2 PRODUCTS

2.01 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
- B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.02 SUPPORTS AND ANCHORS

- A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
 - 1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
 - 2. ASCE 7 (Latest Edition): American Society of Civil Engineers-Minimum Design Loads for Buildings and Other Structures.
 - 3. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
 - 4. NFPA: Pamphlet number 13 and 14 for fire protection systems.
 - 5. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
 - 6. Manufacturer: Mason Industries, Hilti Inc., B-Line/Tolco (Eaton), Anvil, Erico, Kin-Line, Simpson Strong-Tie Co. Inc., Superstrut, Empire, PHD Manufacturing, Carpenter & Paterson, Powers Fasteners or equal.
- B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS SP-58 types listed.
 - 1. Adjustable Steel Clevis Hangers: MSS Type 1.
 - 2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
 - 3. U-Bolts: MSS Type 24.
 - 4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 - a. Plate: Unguided type.
 - b. Plate: Guided type.
 - c. Plate: Hold-down clamp type.
 - 5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.

6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
 7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
 8. Upper Attachment Side Beam Bracket: MSS Type 34
 9. Upper Attachment Side Beam Angle Bracket: MSS Type 34, UL listed and FM Approved.
 10. Single Pipe Roller with Malleable Sockets: MSS Type 41. Rollers are not required for hydronic piping where spring hangers are utilized.
 11. Adjustable Roller Hangers: MSS Type 43. Rollers are not required for hydronic piping where spring hangers are utilized.
 12. Pipe Roll Stands: MSS Type 44.
 13. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
- C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp type by many manufacturers.
- D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8 and or four-bolt riser clamps for heavy loads, MSS Type 42. Provide with 1" thick (minimum) neoprene pad on floor with 1/4" thick steel plate to distribute riser clamp weight to pad.
- E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
1. Steel Turnbuckles: MSS Type 13.
 2. Steel Clevises: MSS Type 14.
 3. Swivel Turnbuckles: MSS Type 15.
 4. Malleable Iron Eye Sockets: MSS Type 16.
 5. Steel Weldless Eye Nuts: MSS Type 17.
- F. Building Attachments: Except as otherwise indicated by the Structural Engineering design, provide factory-fabricated building attachments of one of the following types listed.
1. Concrete Inserts:
 - a. MSS Type 18.
 - b. Manufacturers: Hilti #KCS-MD (for metal deck) or HCI-WF (for wood forms), Simpson Strong Tie #Blue Banger Hanger, Powers Fasteners #Bang-It (for metal deck) or #Wood-Knocker (for wood forms), or equal.
 2. Steel Brackets: One of the following for indicated loading:
 - a. Light Duty: MSS Type 31.
 - b. Medium Duty: MSS Type 32.
 - c. Heavy Duty: MSS Type 33.
 3. Horizontal Travelers: MSS Type 58.

4. Concrete Screw Anchors: For floor mounted attachments with maximum allowable pullout and shear force of 250 lbs. (1.1 kN) per anchor regardless of size.
 - a. Manufacturers: Hilti #Kwik Hus EZ-I, Simpson Strong-Tie #Titen HD (or Rod Hanger version), Powers Fasteners #Wedge-Bolt+ (Screw Anchor), Powers Fasteners #Vertigo+ (Rod Hanger), Powers Fasteners #Snake+ (Internally Threaded Screw Anchor), or equal.
 5. Torque-Controlled Expansion Anchor:
 - a. Manufacturers: Hilti #Kwik Bolt TZ, Simpson Strong Tie #Strong-Bolt 2, Powers Fasteners #Power-Stud+ SD1 or Power-Stud+ SD2, or equal.
 6. Screws and Bolts:
 - a. Manufacturers: Bolt Depot, Fastenal, National Bolt & Nut, or equal.
 7. Eye Bolts:
 - a. Manufacturers: Lawson Products, Sierra Pacific, US Cargo Control, or equal.
 8. Powder-Driven Concrete Anchors:
 - a. Only for existing concrete structures with minimum 4000 psi concrete compressive strength.
 - b. Minimum embedment of 1" (25 mm).
 - c. Maximum allowable load of 50 lbs (0.2 kN) per anchor.
 - d. Manufacturer: Hilti #X or D Series, Powers Fasteners #CSI Series, or equal.
- G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping at hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with adjacent pipe insulation.
1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
 2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
 3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Shield and insulation length shall be 4" for pipe diameters up to 2", length shall be 6" for pipe sizes 2-1/2" to 6", and 12" length (minimum) for sizes greater than 12" diameter. Alternate Shield: Polyisocyanurate Urethane with a minimum flexural strength of 60 psi, fully encased in Snappltz #360 PVC for pipe sizes to 6" diameter.
 4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and joint insulation at clevis hangers and strut-mounted clamps.
 - a. Manufacturers: Hydra-Zorb #Klo-Shure Insulation Couplings or equal.
- H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
 2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.

3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of one-part cement to three-parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: Copper plated brackets and supports for various mounting options. Insulate brackets attached to metal studs with felt.
 - a. Manufacturers: Holdrite or equal.

2.03 PIPE PORTALS

- A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.
- B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
 1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
 2. Insulation to be 1-1/2" thick, 3 lb. density rigid fiberglass.
 3. Curb to have a raised 3" (minimum), 45° cant.
 4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
 5. Curb height to be 8" (minimum) above roof deck.
 6. Cant strips shall be raised to match roof insulation thickness.
 7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
- C. Manufacturer: Roof Products Systems, Pate, or equal.

2.04 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping. Coordinate all pipe stands with structural design. Select stands for rated support weight and spacing. Refer to details on drawings for permanent fixed roof support and curbs.
- B. Compact Pipe Stand:
 1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.
 2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 3. Base: Single piece, vulcanized rubber, molded polypropylene or polycarbonate.
 4. Hardware: Galvanized or stainless steel.
 5. Manufacturers: Dura-Blok, Roof Top Blox, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.

6. Accessories: Mount on protective roof pad with a minimum of 6" material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

C. Single-Pipe Stand:

1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.
2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
3. Base: Single piece, vulcanized rubber, molded polypropylene, or polycarbonate.
4. Vertical Members: Two, galvanized or stainless steel, continuous-thread 1/2-inch (12-mm) rods.
5. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
6. Pipe Supports: Roller, strut clamps, clevis hanger or swivel hanger.
7. Hardware: Galvanized or stainless steel.
8. Manufacturers: Dura-Blok, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.
9. Accessories: Mount on protective roof pad with a minimum of 6" material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed of spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

D. Multiple-Pipe Stand:

1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.
2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
3. Base: Two or more, vulcanized rubber, molded polypropylene, or polycarbonate.
4. Vertical Members: Two or more, galvanized or stainless steel, channels.
5. Horizontal Member: Two or more, adjustable height, galvanized or stainless-steel pipe support slotted channels or plates.
6. Pipe Supports: Roller, strut clamps, clevis hanger or swivel hanger.
7. Hardware: Galvanized or stainless steel.
8. Manufacturers: Dura-Blok, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.
9. Accessories: Mount on protective roof pad with a minimum of 6" material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed of spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

E. Curb and Rail-Mounted Type Pipe Stands:

1. Shop- or field-fabricated pipe supports made from structural-steel shapes, channels, continuous-thread rods, with rollers, strut clamps, clevis hangers or swivel hangers for mounting on permanent stationary roof curbs.

2. Coordinate with structural design and mechanical details for attachment through membrane.
3. Manufacturer: Pate, Thybar, ThyCurb, Roof Products Systems, Protech, FastCurbs, or equal.

2.05 EQUIPMENT/PIPING RAILS

- A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.
- B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
 1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
 2. Provide internal reinforcing supports welded as required to meet application requirements.
 3. Equipment rails to have raised 3" (minimum), 45° cant.
 4. Equipment rails to have 1-1/2" x 1-1/2" wood nailer (minimum) and counterflashing.
 5. Equipment rail height to be 6" (minimum) above roof deck.
 6. Cant shall be raised to match roof insulation thickness.
- C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required. Coordinate with structural design and mechanical details for attachment through membrane.
- D. Manufacturer: Pate, Thybar, ThyCurb, Roof Products Systems, or equal.

2.06 ACCESS DOORS FOR WALL AND CEILING APPLICATIONS

- A. Provide all access doors and panels to service equipment under this work, including those which must be installed, in finished architectural surfaces. Refer to other specification sections for specific access doors associated with ductwork and equipment.
- B. Construction:
 1. Frame: 16-gauge steel (minimum).
 2. Door: 16-gauge steel (minimum) or two layers of 20-gauge steel (minimum) for double wall door construction.
 3. Hinge: 1" flange width, continuous piano hinge.
 4. Latching System: screwdriver latch, allen key latch or T-handle latch for non-public access areas. Cylinder key lock for public access areas. Cam latch for access to fire/life safety systems.
 5. Paint: white prime coated.
- C. Size:
 1. Access doors shall be of a size to permit access and removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer, concealed valve, fire and combination fire/smoke dampers, volume dampers, and other equipment requiring access. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through.

D. Architectural Coordination:

1. Refer to Division 01 Architectural specifications and drawings for additional requirements for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans.
2. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to service equipment under this work and in the proper sequence to coordinate with construction schedule and with prior approval of the Owner's Representative.
3. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
4. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Owner's Representative.

E. Manufacturers: Milcor, Karp, Nystrom, Elmdor/Stoneman, Durodyne, Austin Hardware, or equal.

2.07 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils, hand printed, painted, and felt pen markers are not acceptable.

B. Plastic Pipe Markers:

1. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially or fully cover the circumference of pipe, or insulated pipe, and to attach to pipe without fasteners or adhesive complying with ANSI A13.1. Minimum letter size shall be 1/2" high.
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
5. Nomenclature shall include service type and directional arrow as follows:
 - a. Chilled Water Supply and Return: green background with white lettering.
 - b. Heating Water Supply and Return: yellow background with black lettering.
 - c. Condenser Water Supply and Return: green background with white lettering.
 - d. Heat Pump Loop Supply and Return: green background with white lettering.
 - e. Refrigerant: yellow background with black lettering.
 - f. Exhaust air: blue background with white lettering.
 - g. Other piping services: Comply with ANSI and ASME A13.1 standards.
 - h. Direction of water flow.

C. Plastic Duct Markers:

1. Provide duct labels to indicate the system and direction of flow. Submit a labeling product that is suitable for the surface to be labeled.
 - a. Pressure sensitive, 16" long by 2-1/4" high (minimum), 3 mil thick high gloss adhesive backed vinyl, 1-1/2" high letters, and color coded per ducted service.
 2. Nomenclature shall include service type and directional arrow as follows:
 - a. Supply air (cold service): green background with white lettering.
 - b. Supply air (hot service): yellow background with black lettering.
 - c. Return air: blue background with white lettering.
 - d. Relief air: blue background with white lettering.
 - e. Outside air: blue background with white lettering.
 - f. Exhaust air: blue background with white lettering.
 - g. Other air services: Comply with ANSI and ASME A13.1 standards.
 - h. Direction of air flow.
- D. Valve Tags:
1. Brass Valve Tags: Provide 1-1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
 2. Plastic Laminate Valve Tags (indoors only): Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
 3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves and manufactured specifically for that purpose.
- E. Access Panel Markers: Provide 1/16" thick (minimum) engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or device.
- F. Plastic Equipment Signs:
1. Provide 4-1/2" x 6" (minimum) plastic laminate sign, ANSI A.13 color coded with engraved white core lettering. Minimum letter size shall be 1/2" high.
 2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
 3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - a. Tag number
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.
 4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2"x11" bond paper, tabulate each equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

- G. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.
- H. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Kolbi, or Brimar.

2.08 ACOUSTICAL BLANKET INSULATION

- A. Application:
 - 1. Wrap high noise producing equipment and ductwork where occupied room noise levels cannot be obtained by architectural room barrier construction alone.
 - a. Wrap variable air volume terminal where located above noise sensitive rooms such as conference rooms, lobbies and offices.
 - b. Wrap ductwork where located above noise sensitive rooms such as conference rooms, lobbies and offices.
 - c. Wrap fans where located above noise sensitive rooms such as conference rooms, lobbies and offices.
 - d. Wrap chillers and pumps where located adjacent to noise sensitive rooms.
- B. Manufacturers: Kinetics Noise Control #KNM-100ALQ, or equal by BRD Noise and Vibration Control, GLT Products #Vinaflex with Absorber/Decoupler, or Singer Safety Company, Quilted Fiberglass Panels.
- C. Composite material, quilted, with reinforced aluminized-face, mass loaded limp vinyl bonded to scrim-face, quilted fiberglass absorber/decoupler.
- D. The barrier shall be constructed of a 0.12" (3 mm), minimum, thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 1.0 lbs./ft² (4.9-kg/m²) and shall have a minimum STC rating of 28 as measured in an independent accredited acoustical laboratory in accordance with ASTM E90 and/or E413.
- E. The decoupling layer shall be a combination of 1.0" (25 mm), minimum, fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4" (100 mm) diamond stitch pattern which encapsulates the glass fibers.
- F. The composite material shall be fabricated to include a minimum 2" (50 mm) wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints.
- G. The barrier shall have a Flame Spread Index of no more than 10 and a Smoke Development Index of no more than 40 when tested for Surface Burning Characteristic per ASTM E84.

2.09 ELECTRICAL

- A. General:
 - 1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
 - 2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
 - 3. Set and align all motors and drives in equipment specified herein.

4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
 5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
 6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.
- B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.
- C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
 2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors 3/4 HP and larger shall be rated for 3-phase operation above 200 volts. Unless otherwise noted on plans, all motors up to 1/2 HP shall be rated for 120-volt, single phase operation.
 4. Temperature Rating: Motor meets class B rise with class F insulation.
 5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
 6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
 - b. VFD driven motors to be provided as inverter ready and equipped with a shaft grounding device.
 - c. Bearings:
 - 1) Ball or roller bearings with inner and outer shaft seals.
 - 2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
 - 3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
 - 4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - 5) Enclosure Type:
 - a) Open drip-proof (ODP) motors for indoor use in clean air environments.
 - b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.

- c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.
- d) Explosion proof motors where motor is located in environments with hazardous or flammable quantities of vapors, gases, mists or dusts or where motor is located inside ductwork or cabinets with hazardous vapors, gases, mists or dusts that exceed 25 percent of the lower flammability limit.
- e) Guarded drip-proof motors where exposed to contact by employees or building occupants.
- f) Weather protected Type I for outdoor use, Type II where not housed.
- d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
- e. Noise Rating: "Quiet."
- f. Efficiency:
 - 1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
 - 2) And, motors shall meet the NEMA premium efficiency standard.
- g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:

- 1. Motor Starter Characteristics:
 - a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
 - b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
- 2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
- 3. Magnetic Starters:
 - a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
 - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
 - d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
 - e. Externally operated manual reset.
 - f. Under-voltage release or protection for all motors over 20 hp.
- 4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

- E. Low Voltage Control Wiring:
 - 1. General: 14-gauge, Type THHN, color coded, installed in conduit.
 - 2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

- F. Disconnect Switches:
 - 1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
 - 2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
- B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Owner's Representative.

3.02 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
 - 1. If the contractor must deviate from the manufacturer's recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.03 INSTALLATION

- A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and other trades in locating ceiling air outlets, wall registers, etc.
- B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.04 SUPPORTS AND HANGERS

- A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with the General Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.
- B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where Gypcrete is indicated, install reinforcing bars through opening at top of inserts. Inserts and anchors shall be located no closer than 6" to any edge and no closer than 1" from any pre-tension cables or embedded steel and as required per manufacturer's instructions and Structural Engineer.
- C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.
- D. Install hangers, supports, rails, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers and rails where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- E. Install pipe supports (hangers, rails, etc.) within 12 inches of every change in piping direction (only one support required at each change in direction), end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Supports (hangers, rails, etc.) shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one support is required.
- F. Install hangers, rails, and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- G. Support sprinkler piping and gas independently of other piping.
- H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- I. Hanger Spacing in accordance with following minimum spans for support of individual pipes and a minimum of one hanger per elbow at each change of direction. For straight runs of horizontal piping with no concentrated loads such as valves, flanges, expansion joints, or other components. Sections of piping with concentrated loads will have to be considered carefully and a determination made as to appropriate spacing and rod size for the given situation. Other spacing and rod sizes may be considered in compliance with Table 121.5 of ASME B31.1, ANSI/MSS SP-58 Table 4, and local mechanical code, but shall not exceed 12 feet for any pipe size. Comply with more restrictive requirements of local codes where those exceed the following minimum criteria.
 - 1. Steel Pipe:

Steel Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2" to 1"	7 feet	3/8"
1-1/4" to 2-1/2"	10 feet	3/8"
3" to 4"	12 feet	3/8"
5" to 8"	12 feet	1/2"
10" to 12"	12 feet	5/8"
14" to 16"	12 feet	3/4"

2. Copper Pipe:

Copper Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2"	4 feet	3/8"
3/4" to 2"	6 feet	3/8"
2-1/2" to 4"	8 feet	3/8"
5" to 8"	8 feet	1/2"

3. Plastic/Fiberglass Pipe:

Plastic/Fiberglass Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
Up to 1"	3 feet	3/8"
1-1/4" to 2-1/2"	4 feet	3/8"
3" to 8"	5 feet	1/2"

4. Trapeze support: Provide details stamped by a Registered Structural Engineer for the project state indicating trapeze channels, support rod sizes, and spacing.
5. Maximum threaded rod loading: Below are maximum loads for hanger rods based on ASHRAE Fundamentals Handbook (Pipe Design Chapter) and ASTM A36, with a safety factor.

Maximum Allowable Loading Capacity for Hanger Rod in Tension	
Nominal Rod Diameter	Load (Maximum Weight)
3/8"	610 pounds
1/2"	1,130 pounds
5/8"	1,810 pounds
3/4"	2,710 pounds
7/8"	3,770 pounds
1"	4,960 pounds

J. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
 - a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
 - b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
 - c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

K. Installation of Anchors:

1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends.

L. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

M. Equipment Supports:

1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction. Coordinate size of concrete pads and placement of anchors bolts with structural design. Anchor bolts shall be placed to maintain 6", minimum, or greater distance from concrete pad edges.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:

1. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports to align piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

O. Upper Building Attachments: Powder-actuated fasteners may be used where appropriate for construction materials to which hangers are being attached per the following:

1. Maximum allowable tension load shall not exceed 50 lbs. (0.2 kN) per attachment.
2. May only be used to supporting for ductwork up to two (2) square feet (0.2 m²) in cross sectional area and for control conduit clips.
3. May not be used for support of any piping, equipment, or ductwork greater than two (2) square feet (0.2 m²) in cross sectional area.
4. Use concrete inserts before placing concrete in new construction.
5. Install powder-actuated concrete fasteners after concrete is placed and completely cured to concrete compressive strength of 4000 psi or greater.

6. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
7. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
8. Do not use powder-actuated concrete fasteners for seismic restraints.

3.05 WALL, FLOOR, AND ROOF PENETRATIONS

- A. All pipe and duct penetrations through rated and non-rated assemblies shall be sized to allow for compliance with structural integrity and fire ratings, as applicable. Penetrations of fire-resistance-rated assemblies shall be protected by an approved firestop system installed and tested in accordance with ASTM E814 or UL 1479. The system shall have an F rating/T rating of not less than the required rating of the floor or wall penetrated. Where sleeves are required, the sleeve size shall be installed with the inside clear diameter providing clearances as required below. Coordinate the required opening sizes with the manufacturer of the fire protection products.
 1. Uninsulated pipe penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1" (minimum) to 2" (maximum) larger than the outside diameter of each uninsulated pipe.
 2. Insulated pipes penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1" (minimum) to 2" (maximum) larger than the outside diameter of each pipe, including insulation.
 3. Uninsulated pipe penetrations through fire rated walls and floors, and through roof: penetration sizes shall be a 1/2" (minimum) to 1-1/2" (maximum) larger than the outside diameter of each uninsulated pipe to provide minimum 1/4" annular space between the outside of the pipe surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
 4. Insulated pipe penetrations through fire rated walls and floors, and through roof: pipe penetration sizes shall be a 1/2" (minimum) to 1-1/2" (maximum) larger than the outside diameter of each insulated pipe to provide minimum 1/4" annular space between the outside of the insulation surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
 5. Uninsulated pipe penetrations through foundation and basement walls: penetration sizes shall be larger than the outside diameter of each uninsulated pipe to allow adequate space for installation of mechanical link seals. Coordinate with specific manufacturer requirements.

3.06 ROOF CURBS

- A. Install per manufacturer's instructions.
- B. Coordinate with other trades so units are installed when roofing is being installed, as applicable.
- C. Verify roof insulation thickness and adjust height of perimeter cant strips to accommodate insulation and roofing material installation.
- D. Provide rigid insulation, minimum 1" thick, on exposed elements of roof curb.
- E. Provide additional rigid insulation inside the roof curb perimeter secured to roof surface, around ductwork penetrations, to match the adjacent roof insulation levels (same R-value or greater).

3.07 EQUIPMENT RAILS AND PIPE PORTALS

- A. Install per manufacturer's instructions.
- B. Coordinate with other trades so units are installed when roofing is being installed, as applicable.
- C. Verify roof insulation thickness and adjust height of perimeter cant strips to accommodate insulation and roofing material installation.

3.08 ELECTRICAL COORDINATION

- A. Division 23 installers shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.
- B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the drawings and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- C. Division 23 has responsibilities for electrically powered mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings as follows:
 - 1. Motors: Furnish and install all motors necessary for mechanical equipment.
 - 2. Magnetic Starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
 - 3. Variable Frequency Drives: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
 - 4. Disconnects: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
 - 5. Controls: Division 23 Contractor (including the Building Automation System (BAS) Controls subcontractor) is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:
 - a. Additional control panels beyond what is identified on drawings shall be provided by BAS contractor in order to provide a complete control system at no additional cost to Owner.
 - b. Control relays necessary for controlling Division 23 equipment.
 - c. Control transformers necessary for providing power to controls for Division 23 equipment.
 - d. Line voltage thermostats.
 - e. Low or non-load voltage control components.
 - f. Remote bulb thermostats.
 - g. Non-life safety related valve or damper actuators.
 - h. Float switches.
 - i. Solenoid valves.
 - j. Switches.

- k. Refrigeration controls.
 - l. Communications wiring and conduit between control devices and mechanical equipment. Control wiring gauge in stranded or solid wire configuration shall be the responsibility of the contractor to coordinate with manufacturers for allowable lengths and load requirements to assure complete and operational systems.
 - m. Raceway to support control cabling.
6. Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
- a. Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for use by Division 28 in providing proof of closure.
 - b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed in ductwork by Division 23 but wired to the damper controller by Division 26.
- D. Division 26 Electrical Responsibilities:
- 1. BAS Controls Contractor shall initiate and coordinate a meeting with the Electrical Contractor and General Contractor to coordinate all BAS component locations and wiring requirements prior to start of construction. All additional costs associated with lack a coordinated shall be the responsibility of the BAS Contractor at no additional cost to the Owner.
 - 2. Additional power requirements, including conduit and wiring, for additional or relocated control panels and devices shall be coordinated and the responsibility of the BAS Controls Contractor at no additional cost to Owner.
 - 3. Motors: Provide the power wiring for the motors from servicing panel to motor controller.
 - 4. Magnetic Starters: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring from source panel/disconnect to the starter.
 - 5. Variable Frequency Drives: Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23.
 - 6. Disconnects: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition, provide power wiring between motor and disconnect when the disconnect is not factory installed.
 - 7. Controls: Division 26 is responsible for providing power to mechanical control panels and provide final power connection to Division 23 provided control transformers.
 - 8. Fire/Smoke Dampers: Division 26 is responsible for power wiring to each damper and as follows:
 - a. Where these dampers are part of an integrated smoke control system Division 28 is responsible for providing the detectors and for all fire/smoke detection system wiring necessary to integrate dampers and related end switches into the system.

- b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct smoke detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Division 23, but wired for damper control by Division 26.
- E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.09 FIELD PAINTING

- A. All painting shall be provided under this Division work, unless otherwise specified under Section 09 91 00: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black.
- B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
 - 1. Exposed copper piping.
 - 2. Aluminum jacketed outdoor insulated piping.

3.10 FACTORY PAINTING

- A. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120°F (50°C), the factory painting system must be designed for the temperature service.

3.11 COASTAL OR MARINE ENVIRONMENTS

- A. Coastal and marine environments are characterized by the abundance of sodium chloride (salt) which is carried by sea spray, mist or fog. Salt spray can be carried several miles by ocean breezes and tidal currents, often up to five (5) miles from the coast. As a result, protection of HVAC equipment from ocean-borne electrolytes is necessary to assure long equipment life. Line-of-sight distance from the ocean, prevailing wind direction, relative humidity, wet/dry time, and coil temperature will determine the severity of corrosion potential in the coastal environment. If the condenser coils or evaporator coils face the ocean or faces into the prevailing winds from the coast, there is a higher probability of seawater contamination.

- B. Coils shall have a flexible epoxy polymer electrostatic coating uniformly applied to coil and fin surface areas with no material bridging between fins. Coating shall be applied in factory, not field applied. The coating process will ensure complete coil encapsulation and a uniform dry film thickness from 0.6 to 1.2 mils on all surface areas including fin edges and meet 4B to 5B rating cross-hatch adhesion per ASTM B3359. Corrosion durability will be confirmed through testing to no less than 5,000 hours salt spray resistance per ASTM B117 using scribed aluminum test coupons. Coating shall be applied to all coils rated for air flows greater than 3,000 cfm.
- C. Equipment cabinets shall be coated with painted on all sides of metal skin and framing elements. No exposed metal is allowed. Coating shall be applied in factory, not field applied. The paint shall be applied using powder coating or spray epoxy as required to meet a 5,000 hour salt spray resistance per ASTM B117.

3.12 IDENTIFICATION MARKERS

- A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Piping System Identification:
 - 1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
 - 2. Locate pipe markers as follows:
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes, and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room.
 - g. Vertically spaced at each story transversed.
- C. Ductwork Identification: A minimum of every 50' for all ductwork, 12" or more in diameter or width, where ducts are concealed above accessible ceilings.
- D. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
 - 1. Main control and operating valves, including safety devices.
 - 2. Meters, gauges, thermometers, and similar units.
 - 3. Pumps.
 - 4. Chillers.
 - 5. Boilers.
 - 6. Fans.

7. Compressors and similar motor-driven units.
 8. Hot water system mixing valves and similar equipment.
 9. Heat exchangers and similar equipment.
 10. Balancing dampers and mixing boxes.
 11. Packaged HVAC central-station and zone-type units.
 12. Tanks and pressure vessels.
 13. Strainers, filters, treatment systems and similar equipment.
- E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.
- F. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

3.13 VIBRATION AND DYNAMIC BALANCING

- A. All equipment submitted and installed by Division 23 shall not exceed maximum tolerances as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
1. All Fans: Below severity chart labeled "FAIR", maximum velocity of 0.0786 in/sec, peak.
 2. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
 3. Compressors: Same as pumps.
- B. Where installed equipment noise or vibration is objectionable to the Owner's Representative, it shall be responsibility of the contractor to conduct testing to confirm that the equipment does not exceed the standard.
- C. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.14 TESTING

- A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner's Representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.
- B. Ductwork: Test all air quantities as specified in Section 23 05 93 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.
- C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 23 05 93 – Testing, Adjusting and Balancing.

- D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.
- E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION

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SECTION 23 05 48

VIBRATION ISOLATION FOR PIPING, DUCTWORK AND EQUIPMENT

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- A. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.
- B. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- C. All mechanical equipment, piping and ductwork as noted on the equipment schedule, in the specification or as required by code shall be designed to resist seismic forces. Refer to Section 23 05 49 - Seismic Restraint for Piping, Ductwork and Equipment
- D. This Section includes the following:
 - 1. Vibration isolation curbs, pads and mounts.
 - 2. Flexible ductwork connectors
 - 3. Spring hangers with and without vertical-limit stops.
 - 4. Spring isolators.
 - 5. Restrained uni-directional seismic isolation snubber mounts.
 - 6. Housed seismic spring vibration mounts.
 - 7. Elastomeric hangers.
 - 8. Pipe riser resilient supports.
 - 9. Resilient pipe guides.
 - 10. Air-mounting system.
 - 11. Restrained vibration isolation roof-curb rails.
 - 12. Seismic snubbers.
 - 13. Vibration isolation equipment bases.
 - 14. Flexible piping connectors

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 05 49 - Seismic Restraint for Piping, Ductwork and Equipment.

1.04 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.
- C. IBC: International Building Code with State Amendments.
- D. ICC-ES: ICC-Evaluation Service.

1.05 CODES AND STANDARDS

- A. Provide components conforming to the load requirements of the latest addition of the local building code and the following:
 - 1. International Building Code with AHJ Amendments
 - 2. American Society of Civil Engineers (ASCE):
 - a. ASCE 7 (Latest Edition): Minimum Design Loads for Buildings and Other Structures.
 - 3. The Manufacturers Standardization Society (MSS):
 - a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
 - b. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
 - c. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices
 - d. MSS SP-127: Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
 - 4. Mason West Inc. Seismic Restraint Guidelines 2014 Edition
 - a. For all suspended piping, suspended ductwork and suspended electrical raceways.

1.06 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Refer to Section 23 05 49 - Seismic Restraint for Piping, Ductwork and Equipment for seismic specific requirements.
 - 2. Vibration isolators must be rated for the seismic loading associated with the system and forces calculated for this building location. Seismic forces for new installations are determined per ASCE 7. Refer to Structural Design for seismic factors and design criteria. Select and submit appropriate values for each piece of equipment and sub-system and material type for the project, and base the seismic calculations on these values.

3. Coordinate all seismic and load requirements with the registered professional Structural Engineer.

B. Component Importance Factor:

1. $I_p=1.0$: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
2. $I_p=1.5$: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category; or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
 - a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.
 - b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

1.07 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the CBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Building Structural Limits: The design of supports and restraints shall not exceed the building structure allowable point loads. Coordinate all work with the registered professional Structural Engineer.
- D. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17A of the CBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per IBC Section 1705A all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.

1.08 WARRANTY

- A. Provide minimum one-year warranty requirements, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

1.09 SUBMITTALS

- A. Product Data shall include the following:
 1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
 2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
 3. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

4. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 2. Provide all details of suspension and support for ceiling hung equipment.
 3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint the locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
- C. Manufacturer Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.

- D. Coordination Drawings: Show coordination and plan locations of vibration isolation for HVAC ductwork, piping, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Structural Engineer.
- F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.
- G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.10 WARRANTY

- A. Refer to section 23 05 00 for basic warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS AND APPLICATION

- A. Factory Finishes:
 1. Standard paint applied to factory-assembled equipment before shipping.
 2. Powder coating on springs and housings.
 3. All hardware shall be galvanized or powder coated.
 4. Hot-dip galvanized or powder coating of metal components for exterior use.
 5. Baked enamel or powder coat for metal components for interior use.
- B. Glumac Device Key Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with mechanical equipment found on this project. The tag designation of preferred devices is as follows:

Glumac Isolator Tag	Description
P-1	Vibration isolation waffle pad
P-2	Double deflection neoprene mount
P-3	Uni-directional restrained neoprene snubber mount
P-4	Interlocking uni-directional snubber
S-1	Open spring vibration isolator
S-2	Steel housed seismic spring vibration isolator
S-3	Bellows air spring isolator

S-4	Restrained air spring isolator
C-1	Seismic spring isolation roof curb (20 ton HVAC and below)
C-2	Seismic spring isolation roof curb (Greater than 20 ton HVAC)
C-3	Curb mounted spring isolation roof base
B-1	Integral equipment and motor base
B-2	Integral equipment and motor base
B-3	Concrete filled steel inertia base
H-1	Spring and rubber in shear vibration isolation hanger
G-1	All-directional pipe anchor
G-2	Vertical pipe guide
G-3	Horizontal thrust restraint
SB-1	Sway bracing
F-1	Kevlar/rubber spherical type flexible piping coupling
F-2	Stainless hose flexible piping coupling
F-3	Flexible expansion joints
F-4	Flexible ductwork connector

2.02 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by
 2. Amber/Booth Company (VMC Group)
 3. California Dynamics Corporation.
 4. Kinetics Noise Control.
 5. Vibration Eliminator Co., Inc.
 6. Vibration Isolation.
 7. Vibration Mountings & Controls (VMC Group)
 8. Vibro-Acoustics, Inc
 9. Vibrex (M.W. Saussé & Company, Inc.)
 10. VMC Group

- B. P-1 Style: Neoprene pads shall consist of a 3/4" (19 mm) thick neoprene pad molded in square waffle modules, a minimum 1/4" (6 mm) thick steel load distribution plate and 3/4" (19 mm) hole with a neoprene anchor bolt bushing with a flat washer face. Pads may be single or multiple layers as required for leveling. Manufacturers: Mason #MBSW Series or equal.
- C. P-2 Style: Restrained bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Manufacturers: Mason #BR Series, VMC Group #YRSM3 Series, or equal.
- D. P-3 Style: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6 mm) thick. A minimum air gap of 1/8" (3 mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. No sharp edges such as bolt threads may come in contact with the neoprene bushing. Snubber end caps shall be removable to allow inspection of internal clearances. Manufacturers: Mason #Z-1225 Series or equal.
- E. P-4 Style: All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19 mm) thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3 mm) and not more than 1/4" (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9 mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12 mm) deflection in the x, y and z planes. Manufacturers: Mason #Z-1011 Series or equal.
- F. S-1 Style: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Two base plate holes for attachment to support surface. Manufacturers: Mason #SLFH Series or equal.
- G. S-2 Style: Restrained spring mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the spring and the mounting base plate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8" (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Manufacturers: #SLR Series or #SLRS Series for steel/wood connections and Mason #SLREBP Series or #SLRSEBP Series or #SSLFH Series for concrete connections, or equal.

- H. S-3 Style: Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Manufacturers: Mason #MT and leveling valves Mason #LV, or equal.
- I. S-4 Style: Restrained mountings shall include multiple bellow air springs manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8" (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have test reports or calculations certifying the maximum allowable horizontal and vertical load ratings. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Manufacturers: Mason #SLR-MT for steel connections and Mason #SLREBP for concrete connections and leveling valves Mason #LV, or equal.
- 2.03 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-1) (HVAC UNITS 20 TON AND UNDER CAPACITY)
- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by M.W. Saussé & Company, Inc.
 2. Amber/Booth Company (VMC Group)
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Thybar Corporation.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls (VMC Group)
 10. Vibro-Acoustics, Inc.
 11. VMC Group

- B. C-1 Style: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. Curbs shall consist of continuous sheet metal frames above and below isolators. Isolators shall be adjustable, free-standing and laterally stable and include a 1/4" (6 mm) acoustical neoprene cup and leveling bolt. Spring diameters shall be no less than 0.8 of the compressed height of the spring at the rated load with 50% additional travel to solid. Seismic snubbers with an all directional neoprene bushing and 1/4" (6 mm) air gap shall be incorporated into each corner. A continuous sheet metal flashing shall be attached to the upper frame and be separated from the lower frame by a neoprene weatherseal. The sheet metal flashing shall incorporate removable cover plates for adjustment and inspection of isolators after the unit is set. The unit must be solidly fastened to the top steel frame and the lower sheet metal curb must be attached to the roof structure. Manufacturers: Mason #ISC Series or equal.
- C. C-3 Style: Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the rigid roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder coated springs selected for 0.75" (20 mm) minimum deflection. Travel to solid shall be 1.5" (40 mm) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" (6 mm) so as not to interfere with the spring action except in high winds. Manufacturer's self adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM ductlike closure. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Manufacturers: Mason #CMAB Series or equal.
- 2.04 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-2) (HVAC UNITS OVER 20 TON CAPACITY)
- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Mason, basis of selection or equal by M.W. Saussé & Company, Inc.
 2. Amber/Booth Company (VMC Group)
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Thybar Corporation.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls (VMC Group)
 10. Vibro-Acoustics, Inc.
 11. VMC Group

- B. C-2 Style: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4" (6 mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6 mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" (50 mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure. Manufacturers: Mason #RSC Series or equal.

2.05 VIBRATION ISOLATION STEEL EQUIPMENT BASES

- A. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:
1. Mason, basis of selection or equal by
 2. Amber/Booth Company (VMC Group)
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Vibration Eliminator Co., Inc.
 7. Vibration Isolation.
 8. Vibration Mountings & Controls (VMC Group)
 9. Vibro-Acoustics, Inc.
 10. VMC Group

- B. B-1 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded structural steel angle or channel members. Manufacturers: Mason #MSL Series or equal.
- C. B-2 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" (25 mm) clearance below the base. Manufacturers: Mason #WFSL Series or #TSLR Series, or equal.
- D. B-3 Style: Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows and shall be 6" deep for pumps through 75 hp and 10" deep for pumps 100 hp through 250 hp. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Manufacturers: Mason #BMK Series or #KSL Series or equal.

2.06 SPRING HANGERS

- A. H-1 Style: Spring hangers shall consist of rigid steel frames containing minimum 1-1/4" (32 mm) thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. A seismic rebound washer made of steel and surrounding neoprene shall be provided. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Manufacturers: Mason #RW30N Series or equal.

2.07 PIPE GUIDES AND SUPPORTS

- A. G-1 Style: All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (12 mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. Manufacturers: Mason #ADA Series or equal.
- B. G-2 Style: Vertical sliding pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (20 mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of 1-5/8" (41 mm) upwards or downwards motion, or to meet location requirements. Manufacturers: Mason #VSG Series or equal.

- C. G-3 Style: Horizontal thrust restraints shall consist of a spring element seated in a steel washer reinforced neoprene cup at the bottom, in series with a molded neoprene element. Steel springs shall be free standing and laterally stable. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6 mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Manufacturers: Mason #WBI Series or #WBD Series or equal.

2.08 SWAY BRACING

- A. SB-1 Style: Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles or struts. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of two (2). Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Do not mix cable and steel braces to brace the same system or equipment. Manufacturers: Mason #SCB Series or #SCBH Series, steel brace assemblies shall be Mason #SSB Series, #SSBS Series or #SHB Series, and rod clamps shall be Mason #SRC Series or #UCC Series or equal.

2.09 FLEXIBLE PIPING CONNECTORS

- A. F-1 Style: Flexible spherical expansion joints for pump connections. Shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5-minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Manufacturer shall provide pre-stretching charts for expansion joints when used in conjunction with isolated equipment. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Manufacturers: Mason #SAFEFLEX SFDEJ Series, #SAFEFLEX SFEJ Series, #SAFEFLEX SFDCR Series or #SAFEFLEX SFU Series and Control Rods Mason #CR, or equal.
- B. F-2 Style: Flexible stainless-steel hose shall have stainless steel braid and carbon steel fittings.
1. Sizes 1/2" (15 mm) to 2" (50 mm):

- a. EPDM or Kevlar core hose with stainless steel braid and brass end fittings. Swivel union ends for threaded nipples or copper sweat ends. Minimum 175 psig working pressure rating. Operating temperature range from 32°F to 225°F (0°C to 107°C). Hoses must have sufficient length, minimum 12" (300 mm) long, to accept 1/2" (12 mm) intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Manufacturers: IMI #Versaflo, Nexus #UF Series, Pro Hydronic Specialties, Titus, Victaulic, Hays Fluid Control, or equal.
- 2. Sizes 2-1/2" (65 mm) and larger:
 - a. EPDM, Kevlar or corrugated stainless-steel core hose with stainless-steel braid. Threaded, flanged or brazed weld ends. Minimum 200 psig working pressure rating. Operating temperature range from 32°F to 225°F (0°C to 107°C). Manufacturers: Mason #FFL Flanged, #CPSB Copper, #CSAMN Threaded, or equal.
- C. F-3 Style: Flexible 60° Vee or U-bend braided hose across building or expansion joints. Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose Vee assemblies rated for ±4" (100mm) seismic motion in all planes. Should the application include ±6" (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial. Veeps shall have a minimum burst pressure of four times their rated pressure. Veeps in steel lines shall have stainless hose and braid. Copper lines, bronze hose and braid. Guiding and anchoring shall be as recommended by the manufacturer. Manufacturers: Mason #VFL flanged braided steel Series, #VMN Threaded Braided Stainless Steel Series or #VCPSB Copper Sweat Series, or equal.

2.10 FLEXIBLE DUCTWORK CONNECTORS

- A. F-4 Style: Flexible ductwork connection fabricated of fiberglass canvas with fire resistant rated neoprene and UV resistant coating. Stainless steel metal edge banding.
- B. Flexible Connections (Indoor Applications):
 - 1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
 - 2. Neoprene (polychloroprene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
 - 3. Shall be airtight, watertight and fire retardant.
 - 4. Minimum density of 30 oz. per sq. yard.
 - 5. Temperature range: -40°F to 200°F
 - 6.
 - 7. Neoprene-only connectors are not allowed.
 - 8. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal.
 - 9. Manufacturers: Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.
- C. Flexible Connections (Outdoor Applications):
 - 1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
 - 2. Hypalon (chlorosulfurated polyethylene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.

3. Shall be airtight, watertight and fire retardant. Resistant to sunlight, ozone and weather.
4. Minimum density of 26 oz. per sq. yard.
5. Temperature range: -50°F to 275°F
- 6.
7. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal.
8. Provide flexible cloth insulating blanket to encase flexible connections to maintain ductwork insulation integrity as follows:
 - a. Jacket shall be UV and ozone resistant with Velcro attachment.
 - b. Service Operating Temperature: 0-350°F.
 - c. Jacket and Liner: silicon or teflon impregnated fiberglass or mineral wool cloth.
 - d. Insulation: Aerogel, 2" thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
 - e. Fastening: 2" Nomex Velcro or 1" straps and stainless steel D-rings.
 - f. Thread: Kevlar/stainless steel thread.
 - g. Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, or equal.
9. Manufacturers: Ventfabrics #Ventlon or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

2.11 BRACING DEVICES FOR EQUIPMENT, PIPING, AND DUCTWORK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amber/Booth Company (VMC Group)
 2. California Dynamics Corporation
 3. Cooper B-Line, Inc.
 4. Hilti, Inc.
 5. Kinetics Noise Control
 6. Loos & Co.
 7. Mason Industries
 8. Tolco Incorporated
 9. Unistrut
 10. ISAT, Inc
 11. Vibro-Acoustics, Inc.
 12. VMC Group
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least two (2) times the maximum seismic forces to which they will be subjected.

- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4" (6 mm) thick resilient cushion.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- E. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.
- F. Bushings for Floor-Mounted Equipment Anchorage: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.
- J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
- C. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
- D. All vibration isolator systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- E. Installation of vibration isolators must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- F. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner's Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- H. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- I. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- J. Flexible Pipe Connectors: Install on equipment side of shutoff valves.
- K. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

- L. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.
- M. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- N. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- O. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 VIBRATION ISOLATION OF PIPING

- A. Horizontal Piping: The first three pipe supports from vibration isolated equipment must be vibration isolated to minimize fluid transmitted vibration. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators supporting the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers or equal. Floor supported piping shall rest on Mason Type SLR isolators or equal. Refer to contract drawings for additional vibration isolation requirements for piping. Where piping connects to mechanical equipment install Mason Type SFDEJ or SFU expansion joints or Mason Type FFL stainless hoses if Type SFDEJ or SFU is not suitable for the service.
- B. Riser isolation: Risers that experience excessive thermal expansion shall be suspended from Mason Type 30N spring hangers or supported by Mason Type SLF(H) spring mountings, anchored with Mason Type ADA(H) anchors, and guided with Mason Type VSG(H) sliding guides. Horizontal pipe runs and branches shall be supported on Mason Type 30N spring hangers for the first three supports from the risers. Steel springs shall be selected to provide a minimum of 0.75" static deflection except in those expansion locations where additional deflection is required to limit load changes to + 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.05 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.06 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 AIR MOUNTING SYSTEM DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 05 49

SEISMIC RESTRAINT FOR PIPING, DUCTWORK AND EQUIPMENT

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Seismic restraint and support of piping, ductwork and mechanical equipment as required by code and as designed by a registered Professional Structural Engineer for each related nonstructural equipment restraint.
 - 2. Mechanical component supports and the means how they are attached to the mechanical component shall be designed for the forces and displacements determined in ASCE 7 Chapter 13. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical component.
 - 3. All ductwork designed to carry toxic, highly toxic, flammable gases or used for smoke control shall be seismically braced regardless of size or location.

1.03 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. ASCE: American Society of Civil Engineers.
- C. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- D. IBC: International Building Code with Amendments.
- E. ICC-ES: ICC-Evaluation Service.
- F. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- G. Mechanical Attachments: Means by which components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.
- H. Mechanical Supports: Those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

- I. Mechanical Components: Elements, including, but not limited to, pumps, air handling units, boilers, chillers, pipes, ductwork, and exhaust fans.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 05 48 - Vibration Isolation for Piping, Ductwork and Equipment.
- C. Section 23 21 13 - Hydronic Piping, Valves and Specialties.
- D. Section 23 31 13 - Air Distribution.
- E. Other Division 23 Sections.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Structural Performance: Restraint devices and systems shall withstand the effects of locally defined gravity loads, seismic loads, dead loads, live loads, winds loads and stresses within limits and under conditions indicated per the local building code and ASCE 7. Coordinate all support structures and restraint systems with project registered professional Structural Engineer.
- C. Special Inspections: Provide structural design and Special Inspections as required in Chapter 17A of the local building code and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.
- D. Codes and Standards: Provide components conforming to the seismic load requirements of the latest addition of the local building code and the following:
 - 1. International Building Code with State Amendments
 - 2. ASCE 7 (Latest Edition) - Minimum Design Loads for Buildings and Other Structures
 - a. Ductwork and piping requirements defined in Chapter 13 Seismic Design Requirements for nonstructural Components.
 - b. Seismic Design Categories, B through F, are defined in Chapter 12, Table 12.6-1. Seismic Design Category B and C apply to all structures. While Seismic Design Categories D, E and F may apply to Category I and II buildings not exceeding two stories, light frame construction and/or structures not exceeding 160 in height.
 - c. Nonstructural components in Seismic Design Category A are exempt from seismic design requirements.
 - 3. ASHRAE – Practical Guide to Seismic Restraint (Latest Edition).
 - 4. Mason West Inc. - Seismic Restraint Guidelines (Latest Edition).
 - a. For all suspended piping, suspended ductwork and suspended electrical raceways.

1.06 APPLICABILITY

- A. Seismic restraints are required for nonstructural mechanical systems, but may not be required for the following conditions related to nonstructural components per ASCE 7 Section 13.1.4:
1. Mechanical components in Seismic Design Category B facilities.
 2. Mechanical components in Seismic Design Category C facility if the component Importance Factor, I_p , is equal to 1.0.
 3. Mechanical components in Seismic Design Categories D, E, or F facilities where all of the following apply:
 - a. The component Importance Factor, I_p , is equal to 1.0;
 - b. The component is positively attached to the structure;
 - c. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and any of the following applies:
 - 1) The component weighs 400 lbs. (1,780 N) or less and has a center of mass located four feet (1.22 m) or less above the adjacent floor level; or
 - 2) The component weighs 20 lbs. (89 N) or less; or
 - 3) The distributed ductwork or piping system weighs 5 lbs./ft. (73 N/m) or less.
- B. Seismically restrained systems shall not move more than 2" when pushed and shall not impact the building structure or other nonstructural components. The design force of restraint elements shall be doubled ($2 \times F_p$) to allow for movement up to 2" per ASCE 7.

1.07 PERFORMANCE REQUIREMENTS

- A. Component Importance Factor and Risk Category:
1. $I_p=1.0$: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
 2. Additions, alterations, and repairs involving nonstructural mechanical components in structures designed in accordance with pre-1973 building codes may have a Component Importance Factor of $I_p=1.0$. However, components required to operate for life-safety purposes after an earthquake, including emergency and standby power systems, mechanical smoke removal system, fire alarm panels and egress stairways shall have an $I_p=1.5$.
- B. Building Seismic Design Category:
1. The directions of application of seismic forces used in the design shall be those which will produce the most critical load effects. Seismic Design Categories are classified as B, C, D, E or F. Refer to Architectural and Structural Designs for project specific classification.
- C. Mechanical Seismic Coefficients for Mechanical Components:
1. Refer to ASCE 7 Table 13.6-1 for a_p factor (component amplification factor) and R_p factor (component response modification factor) as required for each unique mechanical component.

1.08 SUBMITTALS

- A. Product Data:
1. Include rated load, rated deflection, and overload capacity for each device or system.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Submit seismic brace product details from the Mason West Seismic Restraint Guidelines detailing compliance with the specifications.
 4. Where products from the Mason West Seismic Restraint Guidelines cannot be used, special details must be submitted for approval.
- B. For each vibration isolation and seismic-restraint device.
1. Seismic restraint calculations must be provided for all connections to the structure.
 2. Calculations must be stamped by a registered professional Structural or Civil Engineer.
 3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 5. Provide flexible joints, supports and piping joints as required to accommodate movement across seismic expansion joints and vertical building drift between floors.
- 1.09 ENGINEERED PIPING SYSTEMS
- A. Where the piping system design indicated on the plans utilizes Mason Industries, Inc. - Mason West, Inc. seismic restraint components, vibration isolators, guides, anchors, expansion compensators and flexible connectors the following requirements apply:
1. Mason Industries, Inc. - Mason West, Inc. products must be installed as shown.
 2. If product substitutions or design changes are made the contractor must provide certified design of the piping system and meet the following conditions:
 - a. Certification must be provided by a registered professional Structural Engineer.
 - b. Certification shall include a statement that all systems have been checked for loads and stresses and that no excessive loads or stresses exist.
 - c. Forces on all anchors, guides, supports, and restraints must not exceed those shown in the original design unless the structure is checked for the larger loads at no cost to the owner.
- B. Where the piping system design is not indicated on the drawings the design is delegated to the contractor with the following requirements for piping certification and analysis:
1. The supports, anchors, guides and seismic braces for systems with significant thermal motion including steam, condensate, high temperature hot water and heating hot water systems must be designed for combined gravity, seismic, pressure and thermal loads.

2. Small diameter pipes (2" diameter and smaller) may not require analysis as determined by the project registered professional Structural Engineer.
3. The results of the analysis shall include reactions at restraints and anchors, maximum pipe displacements and a code compliant report indicating maximum pipe stresses.
4. Where required, seismic restraint components, vibration isolators, guides, anchors, expansion compensators and flexible connectors manufactured by Mason Industries, Inc. and Mason West, Inc. shall be incorporated into the design of the systems.
5. The analysis and design must be performed by a Structural Engineer with 5 years of experience in this field.

1.10 MANUFACTURER AND CONTRACTOR RESPONSIBILITIES

- A. All seismic restraints shall be designed by a registered professional Structural Engineer.
- B. Seismic restraint layouts for piping and ductwork shall be added to the contractor's shop drawings and shall include:
 1. The number, size and location of seismic braces.
 2. Maximum support loads and seismic loads at the seismic brace locations.
 3. Reference to specific details or pages from the Mason West Seismic Restraint Guidelines.
- C. Submit seismic restraint layout drawings and special details for approval of the project registered professional Structural Engineer per the requirements listed in the Mason West Seismic Restraint Guidelines.
- D. Seismic restraint layout drawings shall bear the stamp and signature of the registered professional Structural Engineer who designed the layout of the braces.

1.11 LOADS ON STRUCTURE

- A. The responsibility of determining allowable loads on the structure is the sole responsibility of the project registered professional Structural Engineer.
- B. Maximum support loads and seismic brace loads on the structure must be less than the maximum allowable loads defined by the project registered professional Structural Engineer, as shown on the plans.
- C. Where maximum loads are not listed on the plans or the maximum allowable loads cannot be met, any additional support steel required to reduce support and seismic bracing loads on the structure shall be designed by the project registered professional Structural Engineer.
- D. Mechanical component supports and the means how they are attached to the component shall be designed for the forces and displacements determined in ASCE 7 Section 13.3.1 and 13.3.2. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical component.
- E. Mechanical supports are those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

- F. Mechanical attachments are the means how components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.

1.12 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 INTENT

- A. All seismic restraints described in this section shall be the product of a single manufacturer.
- B. Refer to Section 23 05 00 for additional guidelines for applicable supports and anchors.
- C. Mason Industries products are the basis of these specifications; products of other manufacturers may be submitted for review provided their systems strictly comply with the specifications. Manufacturers: Mason Industries, Hilti Inc., B-Line/Tolco (Eaton), Anvil, Superstrut, or equal.

2.02 SEISMIC SWAY BRACING

- A. Seismic sway braces shall consist of galvanized steel aircraft cables, steel angles or steel struts.
- B. Cable braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads. Brace end connections shall be steel assemblies that swivel to the final installation angle.
- C. Cable brace assemblies shall have published strength and stiffness ratings based on testing per FM-1950 standards.
- D. Angle or strut bracket assemblies shall be FM Approved except as noted below.
- E. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps.
- F. Cable and universal swivel sway brace bracket attachment assemblies shall be Mason Industries #SCB or #SCBH, or equal.
- G. Solid and swivel brace bracket assemblies shall be Mason Industries #Type SSB or #SSBS, or equal.
- H. Rod clamps shall be Mason Industries #SRC or #UCC, or equal.
- I. Hanging Cables with Adjustable Fastener: Wire rope hangers for maximum point loads not exceeding 100 lbs. (45 Kg) for supporting rigid galvanized ductwork and suspended diffusers/grilles/terminal units.

1. Wire Rope: High tensile steel wire rope, to ASTM 1023/1023M, class A zinc coating; 7 by 7 or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi (1,770 N per sq. mm); lengths, diameters, and wire construction to accommodate design loads and as indicated on Construction Shop Drawings.
2. Adjustable Fastener: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lbs. (45 kg) (maximum per hanger).
3. Manufacturers: Gripple #Standard No. 2/3/4/5, Ductmate #Clutcher, or equal.

PART 3 EXECUTION

- 3.01 CONTRACTOR'S STATEMENT OF RESPONSIBILITY: EACH CONTRACTOR RESPONSIBLE FOR INSTALLING A DESIGNATED SEISMIC SYSTEM OR ANY SEISMIC RESISTING COMPONENT MUST SUBMIT A STATEMENT OF RESPONSIBILITY PRIOR TO THE COMMENCEMENT OF WORK TO INCLUDE ACKNOWLEDGMENT OF AWARENESS OF THE NEED FOR SPECIAL INSPECTIONS.
- 3.02 ALL SEISMIC RESTRAINT SYSTEMS MUST BE INSTALLED IN STRICT ACCORDANCE WITH THE MANUFACTURERS WRITTEN INSTRUCTIONS AND ALL CERTIFIED SUBMITTAL DATA.
- 3.03 INSTALLATION OF SEISMIC RESTRAINTS MUST NOT CAUSE ANY CHANGE OF POSITION OF EQUIPMENT, PIPING OR DUCTWORK RESULTING IN STRESSES OR MISALIGNMENT.
- 3.04 NO CONNECTIONS BETWEEN THE PIPING OR DUCTWORK AND THE BUILDING STRUCTURE SHALL BE MADE THAT DEGRADES THE SEISMIC RESTRAINT SYSTEM HEREIN SPECIFIED.
- 3.05 ANY CONFLICTS WITH OTHER TRADES DUE TO INADEQUATE SPACE OR OTHER UNFORESEEN CONDITIONS SHOULD BE BROUGHT TO THE ATTENTION OF THE OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION. CORRECTIVE WORK NECESSITATED BY CONFLICTS AFTER INSTALLATION SHALL BE AT THE RESPONSIBLE CONTRACTOR'S EXPENSE.

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 WORK RELATED IN OTHER SECTIONS

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 09 00 - Building Automation System (BAS) Controls.
- C. Section 23 21 13 - Hydronic Piping, Valves and Specialties.
- D. Section 23 31 13 - Air Distribution.
- E. Division 26 - Electrical.

1.03 SUMMARY

- A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 23 05 00 - Basic Mechanical Requirements.
- B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
 - 1. Air handling systems including supply, return and exhaust.
 - 2. Air distribution ductwork including supply, return and exhaust.
 - 3. Dedicated exhaust systems.
 - 4. Building automation system controls.
 - 5. Hydronic system including heating, chilled water and condenser water.
 - 6. Steam distribution.
 - 7. Smoke control system.
 - 8. Underfloor air distribution system air leakage.
 - 9. Instruction of Owner's personnel for future balancing of systems.

1.04 CODES AND STANDARDS

- A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Reference Standards

1. ANSI/ASHRAE Standard 111 - Measurement, Testing, Adjusting and Balancing of Building HVAC Systems (current edition).
2. ASHRAE - HVAC Applications Handbook: Chapter 38 - Testing, Adjusting and Balancing (current edition).
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, Chapter 6 (current edition).
4. AABC - National Standards for Total System Balance.
5. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
6. SMACNA - HVAC Systems-Testing, Adjusting and Balancing.
7. SMACNA - HVAC Air Duct Leakage Test Manual.
8. ANSI - American National Standards Institute. Comply with the following:
 - a. S1.4: Specifications for Sound Level Meters.
 - b. S1.11: Specifications for Electroacoustics - Octave-Band and Fractional-Octave-Band Filters
9. Building Code, with State Amendments, Chapter 9 Fire Protection Systems.
10. Mechanical Code, with State Amendments, Chapter 4 Ventilation Air Supply.
11. Local Nonresidential Energy Code.

1.05 QUALITY ASSURANCE

- A. Contractor's Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, is not the installer of the system to be tested and is otherwise independent of the project. Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor. Testing and balancing agency must submit qualifications for review and approval prior to acceptance for work.
- B. Penalty: The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.
- C. Retainages: In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.
- D. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 6 months.

- E. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all deficiencies and proposed recommendations to the Owner' Representative, Contractor, Architect and Engineer.
- F. The testing and balancing agency shall provide with their bid a performance guarantee covering all phases of the work as herein specified.
- G. The General and Mechanical Contractors shall cooperate with the selected testing and balancing agency in the following manner:
 - 1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
 - 2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing dampers and valves as required by testing and balancing agency.
 - 3. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
 - 4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
 - 5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.
- H. All air balancing work shall be coordinated with other disciplines to comply with the meet or exceed the minimum requirements of the Americans with Disabilities Act (ADA), Building Code, local amendments and State Energy Code.

1.06 SUBMITTALS

- A. Conform to the Submittals requirements of Division 01.
- B. Forms: The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable.
- C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include key plans identifying all inlets and outlets. Final test reports shall be typed. Handwritten reports are not acceptable.
- D. Maintenance Data: Include, in maintenance manuals, copies of certified and approved test and balance reports and identification of instruments.
- E. Qualifications: The Test and Balance Agency shall submit qualifications of all persons responsible for supervising and performing the on-site testing and balancing work and the name of the certifying agency, NEBB or AABC. Provide a reference list of five (5) similar size projects with contact person and telephone number.
- F. LEED:

1. Air-Balance Report for Prerequisite EQp1: Documentation of work performed per ASHRAE 2.1, Section 7.2.2 - "Air Balancing".
2. TAB Report for Prerequisite EAc2: Documentation of work performed per ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing".

1.07 AGENDA

- A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.
1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.
 2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating and cooling.
 3. The agenda shall include a list of all air and water flows to be performed at all mechanical equipment.
 4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas such as conference rooms.
 5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.
 6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:
 - a. Air terminal configuration.
 - b. Flow direction (supply or exhaust).
 - c. Velocity corrections.
 - d. Effective area applicable to each size and type of air terminal.
 - e. Density corrections.
 7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

1.08 JOB CONDITIONS

- A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
1. Installation and start-up work on equipment or systems to be tested has been completed and documented.
 2. Work area scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
 3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested shall be in their completed normal positions and operation.
 4. All related mechanical systems which may affect the operation of the system to be tested shall be at their normal operating conditions.

PART 2 PRODUCTS

2.01 TEST HOLES

- A. Test holes and ports shall be provided in ducts, housings and pipes as directed by the Balancing Agency. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

2.02 PATCHING MATERIALS

- A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.
 - 1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.
 - 2. Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

2.03 TEST INSTRUMENTS

- A. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. The Owner's Representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
- B. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against Certified Calibrated instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.
- C. Cone Instruments: The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

PART 3 EXECUTION

3.01 PROCEDURES AND INSTRUMENTS, GENERAL

- A. Requirements: All systems and components thereof shall be adjusted to perform as required by approved project drawings and specifications.
- B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four-hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.
- C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
 - 1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
 - 2. All labor, instruments, and appliances required shall be furnished by the Contractor. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.02 DUCT SMOKE DETECTORS

- A. Duct smoke detectors shall be provided and located as required by these specifications and drawings and as required by the building codes and the following:
1. Obtain information from the Contractor who is to furnish the smoke detectors on the proper device placement and installation limitations and on the proper differential pressure across the sampling tubes of the duct detectors and for required air velocity range requirements.
 2. Installing Contractor shall review the manufacturer's installation guidelines for proper mounting locations.
 3. The testing and balancing agency shall be engaged to confirm that proposed mounting locations will not be adversely impacted by airflows.
- B. Duct smoke detectors shall be tested in collaboration with the installing Contractor and project Fire Alarm Contractor to ensure proper air flow sampling and differential pressure.

3.03 DUCTWORK AIR LEAKAGE TESTING

- A. Test and balance agency shall perform active air flow testing of ductwork systems or sections of ductworks. Agency shall inspect and confirm that all ductwork is sealed per the specification requirements prior to performing any testing. Calculate maximum allowable air leakage by system based on total design air flow rate and/or square footage of ductwork. Maximum allowable system air flow leakage shall not exceed 5% of total air volume, or the maximum allowable per local energy or mechanical codes where the allowable limit is less than 5%.
- B. Representative sections totaling 10 percent, or greater, of the total installed duct area shall be tested. Where the tested 10 percent fails to comply with the requirements, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fails to comply then 100 percent of the total installed duct area shall be tested and verified to have a leakage rate that does not exceed the maximum allowable limit. Duct sections shall be selected by the Owner's Representative. Obtain total duct surface area and air flow volumes for each duct section from the installing contractor. Positive pressure leakage testing shall be permitted for negative pressure ductwork.
- C. Additional ductwork leakage testing may be required to meet local energy and mechanical code requirements. Refer to local codes for applicability and requirements.
- D. Ductwork systems to be leakage tested and procedures shall include:
1. Testing shall be performed at 1.5 times the peak design outlet static pressure (external static pressure) from the air handling unit/fan, but not greater than the maximum SMACNA pressure rating of the ductwork construction classification.
 2. Testing is not required of flexible ductwork or ductwork downstream of VAV terminal units.
 3. Leakage through manufactured products, such as air handling units, dampers, fire/smoke dampers and terminal units may be excluded from the leakage calculations based on manufacturer stated values, at pressure, or these units may be temporarily sealed with painter's tape or plastic sheeting during testing to seal any openings and must be removed after testing.
 4. Supply air ductwork from the outlet of the air handling unit/fan to inlet side of terminal units or connection to flexible ductwork. Duct leakage testing is not required downstream of terminal units.

5. All supply, return and exhaust air ductwork located outside the building envelope.
 6. Return and exhaust air ductwork located in unconditioned spaces from inlet of the air handling unit/fan to the ductwork terminations upstream of each return air grille.
- E. For buildings under the jurisdiction of the UMC or CMC provide duct leakage testing in compliance with maximum allowable leakage quantities per code Section 603.10.1, but in no case greater than 5% of the total system air flow volume. Ductwork shall be leak-tested in accordance with the procedures described in SMACNA HVAC Air Duct Leakage Test Manual. The permitted duct leakage shall be not more than the following:
1. $L_{MAX} = C_L P^{0.65}$ where:
 - a. L_{MAX} =maximum permitted leakage (ft³/min/100 sf [0.0001 (m³/s)/m²] duct surface area.
 - b. C_L = Six (6), SMACNA duct leakage class (ft³/min/100 sf [0.0001 (m³/s)/m²] duct surface area at 1 inch water column (0.2 kPa).
 - c. P =test pressure, which shall be equal to the design duct pressure class rating in inches of water column (kPa).
- F. Additional leakage testing in California, per the energy code, requires that duct systems shall be sealed to a leakage rate not to exceed 6% of the fan flow if the duct systems are:
1. Connect to a constant volume, single zone system, air conditioners, heat pumps or furnaces, and,
 2. Serve less than 5,000 square feet of floor area, and
 3. Have more than 25% duct surface area located in one or more of the following places:
 - a. Outdoors, or,
 - b. In a space directly under a floor where the U-factor of the roof is greater than the U-factor of the ceiling, or,
 - c. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or,
 - d. In an unconditioned crawlspace, or,
 - e. In other unconditioned spaces.
- G. Ductwork installer shall prepare ductwork for pressure testing as deemed appropriate to maintain construction schedule. Ductwork may be tested as total systems or in sections. Sectional testing will require documentation to prove the totalized system leakage is within allowable range of entire system. Ductwork inlets and outlets may be temporarily sealed airtight with plastic, or other means, to facilitate testing pressures.
- H. Testing may occur through ductwork devices such as balancing dampers, smoke fire dampers and coils. Manufacturer provided air leakage allowances for such devices may be excluded from duct leakage measurement but must be documented in final report.
- I. The leakage rate shall be confirmed through field verification and diagnostic testing in accordance with procedures defined by Oriflow Air Leakage Test, or equivalent procedure. Perform all testing utilizing a duct leakage testing system, Oriflow Duct Leakage Tester or equal, with calibrated fan, orifice, gauges, ductwork, pressure tips and tubing.

3.04 UNDERFLOOR PLENUM AIR LEAKAGE TESTING

- A. Test and balance agency shall perform active air leakage testing of raised floor plenums. Agency shall inspect and confirm that all plenums are sealed per the specification requirements prior to testing. Agency shall coordinate with commissioning agent and all installing contractors and identify areas where floor plenum integrity has been compromised. Reports of inspections will be submitted to the general contractor.
- B. Plenum Mock-Up & Testing: All subcontractors responsible for constructing or penetrating the underfloor plenum must participate in the construction of an on-site plenum mockup consisting of all planned plenum components, penetrations, seams and openings. The mock-up plenum is to be inspected and tested by the test and balance agency and an independent commissioning agent for air leakage to verify that it was constructed and sealed in accordance with specifications and drawings including meeting the air leakage requirements.
- C. Air leakage requirement for mock-up and final plenums: total air leakage from each plenum should be no more than 5% of the design airflow when tested at a static pressure of 0.10" w.g. (25 Pascals). Areas with leakage exceeding 5% shall be inspected, repaired and retested until such time that plenum leakage is less than 5% of the design air flow for each floor area.
- D. Perform all pressure testing using a calibrated blower door apparatus, such as a Minneapolis Blower Door model 3 as manufactured by the Energy Conservatory. The fan discharge plenum shall be sized to match a typical floor tile, such as 24" x 24". A minimum of three measurements shall be obtained to assure the average pressure does not exceed the allowable leakage rate. Document results in TAB report.

3.05 AIR SYSTEM PROCEDURES

- A. Adjustments: Adjust all air handling systems to provide design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant air conditions.
- B. Equalizers: Equalizing devices shall be adjusted to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.
- C. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).
 - 1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.
 - 2. Restriction imposed by flow regulating devices in or at terminals shall be minimal.
 - 3. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air pattern of diffusion and as indicated on the air distribution drawings.
- D. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 0.5" w.g. and sound level criteria are met.
- E. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.
 - 1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."

2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, airflow in the duct shall be determined by totaling volume of individual terminals served, measured as described herein.
 3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.
- F. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.
- G. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda. Laboratory tests shall be conducted to prove accuracy of testing methodology and test data when so directed. Such tests shall be conducted in conformance with applicable ASHRAE or American Society of Mechanical Engineers (ASME) codes and shall be performed at no additional cost to Owner.
- H. Air Motion: Air motion and distribution shall be as specified and indicated on drawings. The Contractor, at no additional cost to the Owner shall, in addition to air motion and direct measurements, perform smoke tests as requested to demonstrate the air distribution and pattern from air terminals and outlets.
- I. Air system test and balance procedures shall include, but not be limited to the following requirements:
1. Test and adjust blower RPM to design requirements.
 2. Test and record motor full load amperes.
 3. Make pitot tube traverse of main supply ducts and obtain design CFM at fans.
 4. Test and record system static pressures, suction pressure directly at system fan inlet, and outlet pressure directly at system fan outlet or discharge. Test and record static pressure across each component of air handling system (coils, filters, etc.).
 5. Test and adjust system for design CFM recirculated air.
 6. Test and adjust system for design CFM outside air.
 7. Test and record entering air temperatures.
 8. Test and record leaving air temperatures.
 9. Adjust all supply, return and exhaust air ducts to proper design CFM.
 10. Adjust all zones to proper design CFM, supply and return.
 11. Test and adjust duct systems and each diffuser, grille, and/or register to within 10% of design requirements.
 12. Each grille, diffuser and register shall be identified as to location and area.
 13. Operate each variable frequency drive (VFD) and verify controls installation is complete.
 14. Size, type and manufacturer of VAV boxes, diffusers, grilles, registers and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.

15. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustment.
16. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Testing agency shall check all controls requiring adjustment by control installers. Room thermostats shall be checked for cooling and heating response.
17. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
18. Adjust overall system balances to allow all self-closing exterior doors to close from any open position. Maximum interior air pressure in all operational modes shall not exceed 0.05" static pressure relative to the outside air pressure. Comply with chapter 10 of the Building Code to assure that self-closing doors will release with a maximum force of 15 pounds.
19. As part of the work of this contract, the HVAC contractor shall make any changes in the pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.
20. After air balancing is completed and RPM determined, HVAC Contractor shall provide fixed pitch pulleys.
21. All mixing boxes, VAV air valves, control dampers, smoke dampers and similar devices which operate at 100% shut off shall be tested for leakage.
22. Variable Air Volume Fan Systems: The primary balancing mode is 100% outside air with all terminal boxes on a full call for cooling. Also check and record performance at minimum outside air with all terminal boxes on call for full cooling and at minimum outside air with all terminal boxes on call for full heating and at minimum outside air in the deadband range with no call for heating or cooling. Verify that the systems are operating on a stable part of the fan curves in each mode. Record final duct static controller settings.
23. Provide testing of underfloor air distribution plenum floor mock-ups and final floor installation to document that plenum does not exceed 5% air leakage rate at maximum 0.10" w.g. positive differential pressure.
24. Space Pressurization Procedure:
 - a. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
 - b. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
 - c. Measure space pressure differential where pressure is used as the design criteria and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1) For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2) For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3) Test room pressurization first, then zones, and finish with building pressurization.

- d. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- e. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - 1) Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - 2) Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over pressurization and under pressurization, and observe and report on the system's ability to revert to the set point.
 - 3) For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- f. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- g. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.06 ADA COMPLIANCE

- A. All air balancing work shall be coordinated with other disciplines to comply with meeting or exceeding the minimum requirements of the Americans with Disabilities Act (ADA), Chapters 9 and 10 of the Building Code, local amendments and State Energy Code. Final air balancing for all systems in each space shall be verified and adjusted as necessary to meet the following requirements during peak ventilation, smoke control mode, partial ventilation and minimum ventilation modes during occupied and non-occupied hours. The following requirements are provided as consolidated list of minimum ADA requirements:
 - 1. The required force for pushing or pulling open a door other than fire doors shall not exceed 5 pounds.
 - 2. At fire doors the required opening force shall not exceed 15 pounds.
 - 3. At fire doors the doors shall be set in motion when subjected to a force not exceeding 30 pounds.
 - 4. At fire doors the doors shall swing to a full open position when subjected to a force not exceeding 15 pounds.
 - 5. The force to operate door latch releases shall not exceed 5 pounds.
 - 6. The differential pressure between the building lobby and outside shall remain positive between 0.01" w.g., minimum, and 0.05" w.g., maximum, during operational hours.

3.07 AIR SYSTEM DATA

- A. Report: The certified report shall include for each air handling system the data listed below.
 - 1. Equipment (Fan or Factory Fabricated Station Unit):
 - a. Installation data

- 1) Manufacturer and model
 - 2) Size
 - 3) Arrangement, discharge and class
 - 4) Motor hp, voltage, phase, cycles, and full load amps
 - 5) Location and local identification data
- b. Design data
- 1) Data listed in schedules on drawings and specifications.
- c. Fan recorded (test) data
- 1) CFM
 - 2) Static pressure (suction and discharge, across each coil and filter set)
 - 3) RPM
 - 4) Motor operating amps
 - 5) Motor operating bhp
2. Duct Systems:
- a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust:
- 1) Duct size(s)
 - 2) Number of pitot tube (pressure measurements)
 - 3) Sum of velocity measurements (Note: Do not add pressure measurements)
 - 4) Average velocity
 - 5) Recorded (test) cfm
 - 6) Design cfm
- b. Individual air terminals
- 1) Terminal identification supply or exhaust, location and number designation
 - 2) Type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
 - 3) Design and recorded velocities - fpm (state "core," "inlet," etc., as applicable)
 - 4) Design and recorded quantities - cfm (deflector vane or diffusion cone settings)

3.08 WATER SYSTEM PROCEDURES

A. Preparation:

1. Open all valves to fully open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
2. Remove all strainers and clean same. Reinstall.

3. Examine water system and determine if water has been treated and cleaned.
 4. Check pump rotation.
 5. Check expansion tank to determine they are not air bound and the system is completely full of water.
 6. Check all air vents at high points of water systems and determine that all are installed and operating freely.
 7. Check operation of automatic bypass valve.
 8. Operate each variable frequency drive (VFD) and verify controls installation is complete.
 9. Check and set operating temperatures of all equipment at design requirements.
 10. Complete air balance must have been accomplished before actual water balance begins.
- B. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component.
- C. Metering: Water quantities and pressures shall be measured with calibrated meters.
1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment (coils except room units, converters, etc.) prior to the capacity testing.
 2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.
- D. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.
- E. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.
- F. Distribution: Adjustment of distribution shall be affected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided. Manual service valves shall not be used for balancing.
1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.
- G. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.
- H. Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:
1. Set chilled, heating and condenser water pumps to proper gallons per minute delivery.
 2. Adjust chilled water flow through chiller(s).
 3. Adjust heating water flow through boiler(s).
 4. Adjust condenser water flow through cooling tower(s).

5. Test and record entering and leaving water temperatures through chillers, boilers, heat exchangers and cooling towers/fluid coolers.
6. Test and record water temperatures at inlet and outlet side of each terminal unit. Note rise or drop of temperatures from source.
7. Proceed to balance each terminal unit.
8. Upon completion of flow readings and adjustments at coils, mark all settings and record data.
9. After adjustments to coils are made, recheck settings at the pumps, chiller, boilers, and cooling towers and readjust if required.
10. Record and check the following items at each coil.
 - a. Inlet water temperatures.
 - b. Leaving water temperatures.
 - c. Water pressure drop of each coil.
11. Pump operating suction and discharge pressures and final total dynamic head.
12. List all mechanical specifications of pumps.
13. Rated and actual running amperage of pump motor.
14. Water metering device readings.

3.09 WATER SYSTEM DATA

A. Report: The certified report for each water system shall include the data listed below.

1. Pumps:
 - a. Installation data
 - 1) Manufacturer and model
 - 2) Size
 - 3) Type drive
 - 4) Motor hp, voltage, phase, and full load amps
 - b. Design data
 - 1) GPM
 - 2) Head
 - 3) RPM and amps
 - c. Recorded data
 - 1) Discharge pressures (full-flow and no-flow)
 - 2) Suction pressures (full-flow and no-flow) operating head
 - 3) Operating gpm (from pump curves if metering is not provided) no-load
 - 4) Amps
 - 5) Full-flow amps
 - 6) No-flow amps

2. Air Heating and Cooling Equipment:
 - a. Design data
 - 1) Load in Btuh or MBh
 - 2) GPM
 - 3) Entering and leaving water temperature
 - 4) Entering and leaving air conditions (DB and WB)
 - 5) CFM
 - 6) Water pressure drop
 - 7) Entering steam pressure
 - b. Recorded data
 - 1) Type of equipment and identification (location or number designation)
 - 2) Entering and leaving air conditions (DB and WB)
 - 3) Entering and leaving water temperatures
 - 4) GPM
 - 5) Temperature rise or drop
 - 6) Entering steam pressure
3. Water Chilling Units:
 - a. Installation data
 - 1) Manufacturer and model
 - 2) Motor hp, voltage, cycles, phase, and full load amps
 - 3) Part load amperes
 - 4) GPM - chiller and condenser
 - 5) Water pressure drop - chiller and condenser
 - 6) Entering and leaving water temperature - chiller and condenser
 - b. Recorded data (chiller and condenser)
 - 1) GPM
 - 2) Water pressure drop
 - 3) Entering and leaving water temperature
 - 4) Amperes
4. Cooling Towers and Fluid Coolers:
 - a. Installation data
 - 1) Manufacturer and model
 - 2) Motor hp, voltage, cycles, phase, and full load amps
 - 3) Part load amperes
 - 4) GPM
 - 5) Water pressure drop

- 6) Entering and leaving water temperature
- b. Recorded data
 - 1) GPM
 - 2) Water pressure drop
 - 3) Entering and leaving water temperature
 - 4) Amperes
5. Boilers:
 - a. Installation data
 - 1) Manufacturer and model
 - 2) Motor hp, voltage, cycles, phase, and full load amps
 - 3) Part load amperes
 - 4) GPM
 - 5) Water pressure drop
 - 6) Entering and leaving water temperature
 - b. Recorded data
 - 1) GPM
 - 2) Water pressure drop
 - 3) Entering and leaving water temperature
 - 4) Amperes
6. Heat Exchangers:
 - a. Installation Data
 - 1) Manufacturer, model, and type
 - 2) Flow rate
 - 3) Inlet (entering) and outlet (leaving) temperatures
 - 4) Inlet (entering) and outlet (leaving) pressures
 - b. Recorded Data
 - 1) Flow rate
 - 2) Entering and leaving water temperatures
 - 3) Entering and leaving pressures

3.10 HEAT EXCHANGER CAPACITY VERIFICATION

- A. Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the upstream and downstream of the coils.

- B. The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.
- C. Water/water heat exchanger equipment capacity shall be verified by measuring the flow rate and temperature differential of the water.
- D. Capacity verification shall be performed after air and water systems have been balanced.
- E. False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.

3.11 SOUND TEST PROCEDURES

- A. Scope: Tests of sound levels shall be made at each selection point as described in the following:
 - 1. Each normally occupied room or space, including, but not limited to, the following:
 - a. Offices, open and enclosed.
 - b. Conference rooms and breakout rooms.
 - c. Lobbies and waiting rooms.
 - d. Break rooms.
 - e. Retail spaces.
 - f. Dining area.
 - g. Hospitality spaces, guest rooms and patient rooms.
 - h. IT and data equipment rooms.
 - 2. Within five feet of each piece of noise generating equipment, such as chillers, cooling towers/fluid coolers, fans, compressors, pumps, and condensers. Or, within the documented sound measurement distance as listed in the equipment manufacturer literature.
 - 3. Within five feet of property lines where mechanical equipment is located outside the building.
- B. Timing: Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.
 - 1. Measurements shall be taken with all equipment turned off, except that being tested.
 - 2. The required sound levels shall be measured at any point within a room not less than 6 feet from any equipment or air terminal and not closer than 3 feet from any floor, wall, or ceiling surface.
- C. Meters: Sound levels shall be measured with a sound meter complying with ANSI S1.4. The "A" scale shall be used to measure over all sound levels. To determine the specified octave band levels, the above sound level meter, set on "C" scale, shall be supplemented by an octave band analyzer complying with ANSI S1.11.
- D. Equipment Components: The "Equipment Component" of room sound equals LPt-C. The "Equipment Component" of room sound (noise) levels shall be determined for each of eight octave bands as follows:

1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
3. Calculate LPt-LPb; if this value is less than 1, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
4. Determine "c" from the table below.

LPt-LPb (db)	c (db)
1	7
2	4
3	3
4 to 4- ½	2
5 to 5- ½	1 – ½
6 to 7- ½	1
8 to 12	½
over 12	0

3.12 SOUND LEVEL DATA

- A. Report: Certified report shall record data on sound levels, taken at each selected location, as follows:
 1. Source of sound and location.
 2. Diagram or description of relationship of sound source to measuring instrument.
 3. "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
 4. Readings at each specified octave band frequency for equipment being tested turned off (ambient level) and equipment being tested turned on (operating conditions).
 5. "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures".
 6. Graph showing relationship between pressure levels specified and recorded readings
- B. Retest: Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that associated air and water quantities, as previously measured, have not been disrupted.
 1. Certified report shall record all sound data, and their locations, after final adjustments of air and water systems involves

3.13 MEASUREMENT TOLERANCES

- A. Set system air flow rates and water flow rates within the following tolerances:
 1. Supply, return, and exhaust fans and equipment with fans: +/- 10%.
 2. Air outlets and inlets: +/- 10%.

3. Heating water flow rate: +/- 10%.
4. Chilled water flow rate: +/- 10%.
5. Condenser water flow rate: +/- 10%.

3.14 CERTIFIED REPORTS

- A. Submittals: Six (6) copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.
- B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.
- C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.
- D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

3.15 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

- A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.
 1. At the time of final inspection, the Contractor shall recheck, random selection of data (water and air quantities, air motion, and sound levels) recorded in the certified report. In addition, all courtrooms, auditoriums, and conference rooms shall be rechecked.
 2. Points and areas for recheck shall be selected by the commissioning team.
 3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.
 4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.
- B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from design, or a sound level greater than 2 db or more than recorded in the certified report listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost. Retainage time shall be based on the date of the final acceptance of the certified report.
- C. Marking of Settings: Following final acceptance of certified reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION

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SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
1. Ductwork Insulation:
 - a. Duct wrap insulation.
 - b. Acoustic duct lining.
 - c. Rigid board ductwork and plenum insulation.
 - d. Fire Rated duct insulation systems.
 - e. Field applied jackets, indoor and outdoor.
 2. Section Includes insulating the following duct services:
 - a. All supply air ductwork, unless otherwise shown on drawings.
 - b. Return air ductwork in unconditioned spaces and as shown on drawings.
 - c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20') of air handling equipment and where otherwise shown on drawings.
 - d. Outside air ductwork in return plenums, mechanical rooms and in freezing climates.
 - e. Exhaust air ductwork in cold air plenums.
 - f. Vapor/moisture ductwork.
 - g. Insulation to protect fire rated exhaust systems.
 3. Plenums and equipment rooms, as noted.
- B. Types of mechanical insulation specified in this Section include the following:
1. Duct wrap insulation: Glass mineral wool also known as fiberglass.
 2. Duct wrap insulation: Flexible elastomeric foam.
 3. Acoustic duct liner: Glass mineral wool also known as fiberglass.
 4. Acoustic duct liner: Flexible elastomeric foam.
 5. Acoustic duct liner: Polyimide foam.
 6. Rigid board duct and plenum insulation: Calcium silicate.

7. Rigid board duct and plenum insulation: Glass mineral wool.
8. Fire-rated duct insulation: Calcium silicate.
9. Fire-rated duct insulation: Fire-rated board.
10. Fire-rated duct insulation: Fire rated blanket.
11. Insulation jackets.
12. Removable covers
13. Insulation accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 31 13 - Air Distribution.

1.04 DEFINITIONS

- A. Ambient: The air temperature to be maintained in a conditioned room. Typically, between 70°F and 78°F.
- B. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
- C. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
- D. Freezing Climate: Where outdoor design temperature is less than 33° F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.
- E. Unconditioned Space: any space not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.05 INSULATION INDUSTRY DEFINITIONS

- A. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a Kraft paper interleaving with an outer film layer leaving no paper exposed.
- B. ASJ: All Service Jacket (no outer film).
- C. EPA: Environmental Protection Agency.
- D. FHC: Fire Hazard Classification
- E. FSK: Foil-Scrim-Kraft facing or vapor barrier.
- F. FSP: Foil-Scrim-Polyethylene facing or vapor barrier.
- G. ECOSE Technology: a proprietary binder system based on rapidly renewable bio-based materials; rather than petroleum-based chemicals commonly used in other glass mineral wool insulation materials. ECOSE Technology reduces the binder embodied energy by up to 70 percent and does not contain phenol, formaldehyde, acrylics or artificial colors.

- H. Imperative 11, Red List – requires that manufacturers disclose the ingredients in their products to document they are free of Red List chemicals and materials. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.
 - I. PSK: Polypropylene-Scrim-Kraft facing or vapor barrier.
 - J. PVC: Polyvinyl Chloride.
 - K. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE and Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.
 - L. Recycled Content – Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product rather than being placed in a landfill or incinerated.
 - M. Recycled Content – Pre-Consumer (aka Post-Industrial): materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.
 - N. SVF: Synthetic Vitreous Fiber including all forms of manufactured inorganic fibrous insulations such as glass wool (fiberglass) and mineral wool (rock wool and slag wool).
 - O. SSL+: Self-Sealing Lap with Advanced Closure System.
 - P. SSL: Self-Sealing Lap.
 - Q. Underwriter’s Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification.
 - R. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to applicable UL requirements standards for safety and standards of other National and International organizations
 - S. UL Environment Claims Validation (ECV): service and label tests a manufacturer’s product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service enables products to qualify for LEED® MR Credit 4 Recycled Content LEED-NC 2009 or New LEED V-4 Building product disclosure and optimization – sourcing of raw materials.
 - T. UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC’s), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
 - U. UL GREENGUARD Gold Certification: (formerly known as GREENGUARD Children & Schools Certification) offers stricter certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by both The Collaborative for High Performance Schools (CHPS) and the Leadership in Energy Environmental Design (LEED) Building Rating Systems.
 - V. WHO: World Health Organization.
- 1.06 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
 - a. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165: Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
 - c. C167: Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
 - d. C168: Terminology for Thermal Insulation.
 - e. C177: Test Method for Steady-State Heat Flux Measurements and Thermal Transmission by Properties by Means of the Guarded Hot Plate Apparatus.
 - f. C195: Specification for Mineral Fiber Thermal Insulating Cement.
 - g. C196: Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
 - h. C302: Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
 - i. C303: Test Method for Density of Preformed Block-Type Thermal Insulation.
 - j. C305: Test for Thermal Conductivity of Pipe Insulation.
 - k. C356: Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
 - l. C411: Test for Hot-Surface Performance of High Temperature Thermal Insulation.
 - m. C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - n. C449: Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - o. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - p. C533: Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - q. C534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - r. C547: Specification for Mineral Fiber Preformed Pipe Insulation.
 - s. C552: Specification for Cellular Glass Block and Pipe Thermal Insulation.
 - t. C612: Specification for Mineral Fiber Block and Board Thermal Insulation.
 - u. C755: Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation.
 - v. C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - w. C916: Standard Specification for Adhesives for Duct Thermal Insulation.
 - x. C921: Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
 - y. C1104: Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.

- z. C1071: Standard Specification for Thermal and Acoustical Insulation.
 - aa. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
 - bb. C1290: Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 - cc. C1338: Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - dd. D1667: Standard Specification for Flexible Cellular Material-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
 - ee. E84: Test Method for Surface Burning Characteristics of Building Materials.
 - ff. E119: Test for Fire Resistance.
 - gg. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - hh. G22: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
- a. 90: Energy Conservation in New Building Design.
3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
- a. 255: Test Methods, Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratory (UL): Manufacture and test insulation in accordance with the UL Standards, including:
- a. 181: Standard for Factory-Made Air Ducts and Air Connectors.
 - b. 723: Standard for Test for Surface Burning Characteristics of Building Materials.
 - c. 2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.
- D. Flame/Smoke Rating: Materials exposed within ducts or plenums shall be noncombustible. Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method or UL 723. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Discrete plumbing, mechanical, and electrical products that are located in a plenum and have exposed combustible material shall be in accordance with UL 2043.

- E. Corrosiveness: Passes ASTM C1617-05, Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals.
- F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.
- G. Sustainable Project Requirements: Formaldehyde Free: Third party certified with UL Environment Validation or Scientific Certification Systems (SCS).
 - 2. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products
- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also, furnish necessary test data certified by an independent testing laboratory. Submit samples.
 - 1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
 - a. Pentabrominated diphenyl ether (CAS#32534-81-9).
 - b. Octabrominated diphenyl ether (CAS#32536-52-0).
 - c. Decabrominated diphenyl ether (CAS#1163-19-5).
 - 2. All materials, adhesives, mastics and sealants installed in California shall meet or exceed the minimum testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing and Evaluation of Volatile Organic Emissions from Indoor Sources using Environmental Chambers."
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.08 LEED ACTION SUBMITTALS:

- A. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
- B. Product Data for Credit MR 5 Regional Materials: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
- C. LEED v 4, Product Data for Credit EA 2: For products and materials significant to the energy performance of a structure, provide documentation that indicates that insulation levels are significant to increasing the level of energy performance beyond the prerequisite standard.

- D. LEED v 4, Product Data for Credit MR 2: For products and materials to comply with Building Product Disclosure & Optimization, provide data/evidence that substantiates Environmental Product Declaration and Multi Attribute Optimization requirements.
- E. LEED v 4, Product Data for Credit MR 3: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
- F. LEED v 4, Product Data for Credit MR 4: For products having recycled content documentation; indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
- G. LEED v 4, Product Data for Credit EQ 2: For products and materials to comply with low emittance standards, provide documentation substantiating that insulation products comply with requisite low emittance standards.
- H. LEED v 4, Product Data for Credit EQ 5: For products and materials to meet the standard for both thermal comfort design and thermal comfort control, provide data to support that insulation products are significant to thermal comfort design and thermal comfort control.
- I. LEED v 4, Product Data for Credit EQ 9: For products and materials that contribute to the design and performance of workspaces that promote occupants well-being, productivity, and communication, provide data/documentation supporting acoustical benefits of Glass Mineral Wool insulation products.
- J. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
- B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.10 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIRMENTS

- A. Comply with requirements in "PART 3 – EXECUTION" for Table 1, Table 2 and Table 3 for application of insulation materials.

- B. Products shall not contain asbestos, lead, mercury or mercury compounds if possible. Products shall be certified UL GREENGUARD Gold or Indoor Advantage Gold if possible.
- C. Insulation materials for use on austenitic stainless steel shall be qualified per ASTM C795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Each insulation material has been provided a descriptive key code, such as **DW-A**, to simplify the organization and application of materials in following sub-sections.
- F. Acceptable manufacturers include Knauf, Johns Manville, Owens-Corning, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.02 DUCT WRAP INSULATION (IDENTIFIED BY KEY CODE **DW** AND IN TABLE 1)

- A. **DW-A**, Flexible Glass Mineral Wool Blanket:
 1. Application: Exterior insulation wrap for ductwork or other HVAC systems.
 2. Flexible Glass Mineral Wool Blanket bonded with a bio-based thermosetting resin:
 3. Comply with ASTM C553, ASTM C1290, UL 723, and UL Greenguard certified.
 4. K-value: 0.29 Btu·in./(hr.·ft²·°F) at 75°F installed full thickness (maximum). Equivalent to "R-Value" per inch of 3.4 (hr.·ft²·°F)/Btu·in. (minimum).
 5. Density: 0.75 lb./cu.ft. (minimum).
 6. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft. Or, PSK (Polypropylene-Scrim-Kraft) plastic vapor barrier.
 7. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" section.
 8. Maximum operating temperature: 250°F.
 9. Flame spread index: ASTM E84, less than 25.
 10. Smoke developed index: ASTM E84, less than 50.
 11. Manufacturers: Knauf Insulation #Atmosphere Duct Wrap, Owens Corning #SOFTR Duct Wrap, John Manville #Microlite FSK or PSK or equal.
- B. **DW-B**, Elastomeric Foam Flexible Insulation:
 1. Application: Exterior insulation wrap for ductwork or other HVAC systems.
 2. Elastomeric foam insulation with acrylic polymer airstream coating.
 3. Comply with ASTM D1622, ASTM C1104, ASTM C518, and UL Greenguard Low VOC certified.
 4. K-value: 0.25 Btu·in./(hr.·ft²·°F) at 75°F per ASTM C518. Equivalent to "R-Value" per inch of 4.0 (hr.·ft²·°F)/Btu·in. (minimum).
 5. Density: ASTM D 1622, 3.0-6.0 lb./ft³.
 6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
 7. Fungal and bacteria resistance: ASTM G 21/22, no growth.
 8. Maximum operating temperature: 250°F.

9. Flame spread index: ASTM E84, less than 25.
10. Smoke developed index: ASTM E84, less than 50.
11. Adhesive: UL listed waterproof type compliant with ASTM C916.
12. Manufacturers: Armacell #AP Armaflex and #AP Coilflex or equal.

C. **DW-C**, Black PSK-Faced Flexible Glass Mineral Wool Blanket for Visible Exposed Ducts:

1. Application: Exterior insulation wrap for exposed ductwork or other HVAC systems.
2. Flexible Glass Mineral Wool Blanket bonded with a bio-based thermosetting resin:
3. Comply with ASTM C553, ASTM C1290, UL 723, and UL Greenguard certified.
4. K-value: 0.29 Btu·in./(hr.·ft²·°F) at 75°F installed full thickness (maximum). Equivalent to "R-Value" per inch of 3.4 (hr.·ft²·°F)/Btu·in. (minimum).
5. Density: 0.75 lb./cu.ft. (minimum).
6. Vapor Barrier Jacket: Black PSK (Polypropylene-Scrim-Kraft) faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft.
7. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" section.
8. Maximum operating temperature: 250°F.
9. Flame spread index: ASTM E84, less than 25.
10. Smoke developed index: ASTM E84, less than 50.
11. Manufacturers: John Manville #Microlite Black PSK or equal.

2.03 ACOUSTIC DUCT LINER (IDENTIFIED BY KEY CODE **ADL** AND IN TABLE 3).

A. **ADL-A**, Glass Mineral Wool Acoustic Duct Liner:

1. Application: Internal insulated duct lining for acoustic or thermal purposes.
2. Fiberglass acoustical duct liner bonded with a bio based thermosetting resin mat fiber-free facing.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
5. K-value: 0.24 Btu·in./(hr.·ft²·°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.2 (hr.·ft²·°F)/Btu·in. (minimum).
6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.70 based on ASTM C423 Type "A" mounting. Minimum 1" thickness.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

14. Manufacturers: Johns Manville #Linacoustic RC, Knauf Insulation #Atmosphere with ECOSE, Owens Corning #QuietR Duct Liner HD or Duct Liner Board or equal.

B. **ADL-B**, Flexible Elastomeric Foam Duct Liner:

1. Application: Internal insulated duct lining for thermal purposes. Not ideal for acoustics as the performance is not equivalent to that of fiberglass liner.
2. Elastomeric foam insulation with acrylic polymer airstream coating.
3. K-value: ASTM C518, 0.25 Btu·in./(hr·ft²·°F) at 75°F per ASTM C518. Equivalent to "R-Value" per inch of 4.0 (hr·ft²·°F)/Btu·in. (minimum).
4. Density: ASTM D 1622, 3.0-6.0 lbs./ft³.
5. Water vapor absorption: ASTM C209, less than 2% by weight.
6. Fungal and bacteria resistance: ASTM G21/22, no growth.
7. Noise Reduction Coefficient: ASTM C 423, 0.49 or higher based on "Type A mounting".
8. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
9. Maximum operating temperature: 250°F.
10. Flame spread index: ASTM E84, less than 25.
11. Smoke developed index: ASTM E84, less than 50.
12. Adhesive: UL listed waterproof type compliant with ASTM C916.
13. Greenguard certified, low VOC.
14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
15. Manufacturers: Armacell #AP Armaflex, Armacell #AP Coilflex, Armacell #AP Spiralflex or equal.

C. **ADL-C**, Polyimide Foam Acoustic Duct Liner:

1. Application: Internal insulated duct lining for thermal purposes. Not ideal for acoustics as the performance is not equivalent to that of fiberglass liner.
2. Greenguard certified, low VOC.
3. Polyimide foam insulation with acrylic polymer airstream coating.
4. K-value: ASTM C518, 0.30 Btu·in./(hr·ft²·°F) at 75°F per ASTM C518. Equivalent to "R-Value" per inch of 3.3 (hr·ft²·°F)/Btu·in. (minimum).
5. Density: ASTM D 3574, 0.80 lbs./ft³.
6. Water vapor absorption: ASTM C1104, less than 2% by weight.
7. Fungal and bacteria resistance: ASTM G21/22, no growth.
8. Noise Reduction Coefficient: ASTM C423, 0.70 or higher based on "Type A mounting".
9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Adhesive: UL listed waterproof type compliant with ASTM C916.
14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

15. Manufacturers: Boyd Corporation #SOLCOUSTIC or equal.

D. **ADL-D**, Round Duct Liner:

1. Application: Internal insulated round duct lining for acoustic or thermal purposes.
2. Fiberglass acoustical duct liner bonded with a bio based thermosetting resin.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
5. K-value: 0.23 Btu·in./(hr·ft²·°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.3 (hr·ft²·°F)/Btu·in. (minimum).
6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.75 based on ASTM C423 Type "A" mounting. Minimum 1" thickness.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Factory-formed grooves at sufficient intervals to prevent air gaps between back of insulation and spiral duct surface.
14. Manufacturers: Owens Corning #QuietZone Spiral Duct Liner, Johns Manville #Spiracoustic Plus or equal.

2.04 RIGID FIBERGLASS BOARD DUCTWORK AND PLENUM INSULATION (IDENTIFIED BY KEY CODE **RB** BELOW AND IN TABLE 2)

A. **RB-A**, Rigid fiberglass duct board:

1. Application: Rigid duct boards for insulating metal plenums and metal ductwork where rigidity is required.
2. Fiberglass duct board with a bio based thermosetting resin.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
5. K-value: 0.23 Btu·in./(hr·ft²·°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.3 (hr·ft²·°F)/Btu·in. (minimum).
6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.75 based on ASTM C423 Type "A" mounting. Minimum 1" thickness.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.

12. Smoke developed index: ASTM E84, less than 50.
13. Density: 3.0 lbs./cu ft. (minimum).
14. Vapor Barrier Jacket: ASJ+ (All Service Jacket) or FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft paper.
15. Manufacturers: Knauf #Atmosphere Air Duct Board, Johns Manville #SuperDuct RC, Owens Corning #QuietR Duct Board, Certainteed #Ultra*Duct or equal.

2.05 FIRE-RATED INSULATION SYSTEMS

- A. **FRI-A**, Hydrous Calcium Silicate for wrapping exhaust pipes and mufflers from generators and engines:
1. Rigid Molded Block Insulation; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range. ASTM C5333 compliant.
 2. "K" Value: $0.397 \text{ Btu} \cdot \text{in.} / (\text{hr.} \cdot \text{ft}^2 \cdot ^\circ\text{F})$ at 300°F. Equivalent to "R-Value" per inch of $2.5 \text{ (hr.} \cdot \text{ft}^2 \cdot ^\circ\text{F}) / \text{Btu} \cdot \text{in.}$ (minimum).
 3. Maximum Service Temperature: 1,200°F.
 4. Compressive Strength (block): Minimum of 100 psi to produce 5% compression.
 5. Tie Bands: Secure blocks in places with staggered joints using 3/8" or 1/2" stainless steel bands on 12" centers.
 6. Manufacturers: Johns Manville #Thermo-12 Gold or equal.
- B. **FRI-C**, Fire-Rated Board:
1. Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700°F (927°C).
 2. Comply with ASTM C656, Type II, Grade 6.
 3. Compliant with ASTM E119, ASTM E814, UL 263, UL 1479, UL 1709 and NFPA 251 for one and two hour fire protection.
 4. Flame spread index: ASTM E84, equal to 0.
 5. Smoke developed index: ASTM E84, equal to 0.
 6. Density (minimum): 28 lb./cu.ft.
 7. "R-Value" per inch thickness (minimum): $1.7 \text{ (hr} \cdot \text{ft}^2 \cdot ^\circ\text{F}) / \text{Btu}$ at 75°F.
 8. Manufacturers: Johns Manville #Super Firetemp M or equal.
- C. **FRI-D**, Fire Barrier Duct Wrap for ventilation ducts:
1. High-temperature, flexible, blanket insulation with FSK jacket that is NRTL (Nationally Recognized Test Lab) tested and certified to provide a 1-hour or 2-hour fire rating. Apply one layer for ventilation (supply, return, environmental exhaust) ducts and life safety ducts.
 2. Compliant with ISO 6944.
 3. Density (minimum): 6 lb./cu.ft.
 4. Thickness (minimum): 1.5" thick (38 mm).
 5. "R-Value" per inch thickness (minimum): $4.0 \text{ (hr} \cdot \text{ft}^2 \cdot ^\circ\text{F}) / \text{Btu}$ at 75°F.
 6. Maximum operating temperature: 2192°F (1200°C).

7. Flame spread index: ASTM E84, less than 25.
8. Smoke developed index: ASTM E84, less than 50.
9. Manufacturers: 3M #Fire Barrier Duct Wrap 615+, Morgan #FireMaster FastWrap XL, Morgan #Pyroscat DuctWrap XL, Unifrax #FyreWrap Elite 1.5 or equal.

D. **FRI-E**, Fire Barrier Plenum Wrap for encapsulating non-rated (plastic) pipes and cables:

1. High-temperature, flexible, blanket insulation with FSK jacket that is NRTL (Nationally Recognized Test Lab) tested and certified. Apply one layer blanket to wrap combustible items in an air plenum area.
2. Density (minimum): 8 lb./cu.ft.
3. Thickness (minimum): 0.5" thick (13 mm).
4. Maximum operating temperature: 2300°F (1260°C).
5. Flame spread index: ASTM E84, less than 25.
6. Smoke developed index: ASTM E84, less than 50.
7. Manufacturers: 3M #Fire Barrier Duct Wrap 5A+, Unifrax #FyreWrap 0.5 Plenum Insulation, Morgan #FireMaster PlenumWrap or equal.

2.06 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive:

1. Comply with MIL-A-24179A, Type II, Class I.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: Aeroflex #Aeroseal, Armacell #Armaflex 520, H.B.Fuller #Foster 85-75, K-Flex #720-LVOC or equal.

C. Mineral-Fiber Adhesive:

1. Comply with MIL-A-3316C, Class 2, Grade A.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: H.B.Fuller #Childers Chil-Quik CP-127, H.B.Fuller #Foster 85-60 or 85-75, Mon-Eco Industries # 22 Series or equal.

D. ASJ+ Adhesive, and FSK Jacket Adhesive:

1. Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: H.B.Fuller #Childers Chil-Quik CP-127, H.B.Fuller #Foster 85-60 or 85-75, Mon-Eco Industries #22 Series or equal.

E. PVC Jacket Adhesive:

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Manufacturer: Dow Corning #739 Plastic Adhesive, Johns Manville #Zeston Perma-Weld, Speedline #Polyco Adhesive Low VOC or equal.

2.07 MASTICS

- A. Materials shall be compatible with ductwork material, insulation materials, jackets, and substrates and for sealing joints and seams.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 2. Service Temperature Range: -20°F to +180°F (-29°C to +82°C).
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.
 5. Manufacturer: H.B.Fuller #Foster 30-90, Vimasco #749 Vapor-Blok or equal.
- D. Vapor-Barrier Mastic: Solvent based; suitable for indoor use.
 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
 2. Service Temperature Range: 0 to 180°F (Minus 18 to plus 82°C).
 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 4. Color: White.
 5. Manufacturer: H.B.Fuller #Childers CP-30, H.B.Fuller #Foster 30-35, Mon-Eco Industries #55-10 or equal.
- E. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use for below ambient services.
 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
 2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104°C).
 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 4. Color: White.
 5. Manufacturer: H.B.Fuller #Foster 60-95/60-96 or equal.
- F. Breather Mastic: Water based; suitable for indoor and outdoor use for above ambient services.
 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
 3. Solids Content: 60 percent by volume and 66 percent by weight.

4. Color: White.
5. Manufacturer: H.B.Fuller #Childers CP-10, H.B.Fuller #Foster 46-50, Mon-Eco Industries #55-50, Vimasco #WC-1 or WC-5 or equal.

2.08 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 1241°C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturer: H. B. Fuller Company #Childers CP-76, Eagle Bridges - Marathon Industries #405, H. B. Fuller Company #Foster 95-44, Mon-Eco Industries, Inc.#44-05 or equal.

B. ASJ+ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturer: H. B. Fuller Company #Childers CP-76 or equal.

2.09 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304, 0.020 inch (0.50 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
4. Manufacturer: ITW Insulation Systems, Gerrard Strapping and Seals, RPR Products #Insul-Mate Strapping or equal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated. Manufacturer: AGM Industries, Inc. #CWP-1, GEMCO #CD, Midwest Fasteners #CD, Nelson Stud Welding #TPA/TPC/TPS or equal.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer. Manufacturer: AGM Industries #CHP-1, GEMCO #Cupped Head Weld Pin, Midwest Fasteners #Cupped Head, Nelson Stud Welding #CHP or equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel coordinated with application, fully annealed, 12 gauge, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - d. Manufacturer: AGM Industries #Tactoo Perforated Base Insul-Hangers, GEMCO #Perforated Base, Midwest Fasteners #Spindle or equal.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - d. Manufacturer: GEMCO #Nylon Hangers, Midwest Fasteners #Nylon Insulation Hangers or equal.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, as coordinated with application. 12-gauge, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 - d. Manufacturer: AGM Industries #Tactoo Self-Adhering Insul-Hangers, GEMCO; #Peel & Press, Midwest Fasteners #Self Stick or equal.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch- (0.41-mm-) thick, galvanized-steel, aluminum or stainless steel sheet, as coordinated with application with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - b. Manufacturer: AGM Industries #RC-150, GEMCO #R-150, Midwest Fasteners #WA-150, Nelson Stud Welding #Speed Clips or equal.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Manufacturer: GEMCO, Midwest Fasteners or equal.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel
- 2.10 LAGGING ADHESIVES
- A. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
- B. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
 2. Service Temperature Range: 0 to +180°F (-18°C to +82°C).
 3. Color: White.
 4. Manufacturer: H.B.Fuller #Childers CP-50, H.B.Fuller #Foster 30-36, Vimasco #713 or 714 or equal.
- 2.11 TAPES
- A. ASJ+ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 11.5 mils (0.29 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf./inch (7.2 N/mm) in width.
 6. ASJ+ Tape Disks and Squares: Precut disks or squares of ASJ+ tape.
 7. Manufacturer: ABI Ideal Tape #428 AWF ASJ+, Avery Dennison Corporation Specialty Tapes Division #Fasson 0836, Compac Corporation #104 and 105, Venture Tape #1540 CW Plus, #1542 CW Plus, and #1542 CW Plus/SQ or equal.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 6.5 mils (0.16 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
 7. Manufacturer: ABI Ideal Tape #491 AWF FSK, Avery Dennison Corporation Specialty Tapes Division #Fasson 0827, Compac Corporation #110 and 111, Venture Tape #1525 CW NT, #1528 CW, and #1528 CW/SQ or equal.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications and UL 723 compliant.
1. Width: 2 inches (50 mm).
 2. Thickness: 6 mils (0.15 mm).
 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
 6. Manufacturer: ABI Ideal Tape #370 White PVC tape, Compac Corporation #130, Venture Tape #1506 CW NS or equal.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL181 compliant.
1. Width: 2 inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
 6. Manufacturer: ABI Ideal Tape Division #488 AWF, Avery Dennison Corporation #Specialty Tapes Division Fasson 0800, Compac Corporation #120, Venture Tape #3520 CW or equal.
- 2.12 FIELD APPLIED DUCTWORK INSULATION JACKETS
- A. Field Applied Jackets (For Exterior Applications):
1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment. All longitudinal seams shall be located on bottom of ductwork.
 2. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
 3. Aluminum Jacket: 0.016" aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
 4. PVC Jacket: Johns Manville #Zeston 300, 30 mil thick, white.
 5. Circumferential joints shall be wide enough to provide weather-proofing jacket.
 6. Secure jacket with 3/8" or 1/2" stainless steel bands on 12" centers for round ductwork and objects.
 7. Secure to rectangular sheet metal with sheet metal screws. Seal screw penetrations with silicone caulk.
- B. Field Applied Jackets (For Interior Applications):

1. All longitudinal seams shall be located on bottom of ductwork.
2. PVC Plastic: One-piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
3. Manufacturer: Johns Manville #Zeston 2000 or equal.

2.13 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ+: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ+-SSL: ASJ+ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.14 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Manufacturer: Johns Manville #Zeston, P.I.C. Plastics #FG Series, Proto Corporation #LoSmoke, Speedline Corporation #SmokeSafe or equal.
- D. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier: 3-mil (0.076 mm) thick polysurlyn.
 2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier: 3-mil (0.076 mm) thick polysurlyn.

3. Manufacturer: H. B. Fuller Company #Childers Metal Jacketing Systems, ITW Insulation Systems #Aluminum and Stainless Steel Jacketing, RPR Products #Insul-Mate or equal.

E. Self-Adhesive Outdoor Jacket:

1. 60-mil (1.5 mm) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
2. Manufacturer: Polyguard Products, Inc. #Alumaguard 60 or equal.

2.15 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 4 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts. Manufacturer: H. B. Fuller Company #Childers Chil-Glas No. 5 or equal.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts. Manufacturer: H. B. Fuller Company #Foster 42-24 Mast-A-Fab, Vimasco Corporation #Elastafab 894 or equal.

2.16 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd. (271 g/sq. m). Manufacturer: Alpha Associates, Inc. #84215/9383 or equal.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.
- B. Verify that all surfaces are clean, dry and free of foreign material.

3.02 INSTALLATION

- A. General:
 1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
 2. Remove and replace any insulation that has become wet or damaged during the construction process.
 3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
 - a. Ductwork support angle or struts.

- 1) To prevent crushing of low density insulation, provide separator or high density insulation at point of support. A 12 inch wide strip of 6 pcf density, glass mineral wool board or similar manufactured product, across the bottom side of the duct. Vapor barrier to continue unbroken at point of support.
- 2) As an alternative method, where the duct sits directly on the Unistrut or similar support, install board material on either side of the support to allow duct wrap to be tented over the support, providing a smooth transition over the support and maintaining thickness. Rigid 3 pcf board may be used in this method.

B. Insulation Applied on the Outside/Exterior of the Duct:

1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket.
2. Seal all vapor retardant jacket seams and penetrations with 3" wide pressure-sensitive vapor barrier tape matching the insulation facing.
3. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
4. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
5. For ductwork exposed in mechanical equipment rooms below 7' or in finished spaces, finish with jacket material.
6. For interior vapor/moisture conveying duct applications, install glass mineral wool insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer's requirements and as required by local code authorities.
7. Ducts installed exposed outside the building:
 - a. For exterior applications where insulation is on the outside of the duct, provide insulation with a weather protection metal jacket or double wall construction.
 - b. All exposed to weather exterior metallic ductwork exposed or covered with cladding is to be built with a crown or reverse cross break to shed moisture.

C. Installation of Mineral-Fiber Insulation (Blanket or Rigid Type):

1. Secure weld pins to duct using adhesive recommended for ductwork material. Pins shall be installed on a minimum of three sides of each duct to assure proper support. For overhead ductwork - pins are not required on the top of the ducts. For underfloor ducts - pins are not required on bottom side of ducts. For vertical ducts - pins are not required on surface facing wall. Install pins as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller: Place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) on center.
 - b. On duct sides with dimensions larger than 18 inches (450 mm): Place pins 16 inches (400 mm) on center each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing and reinforcement points.
 - c. Pins may be omitted from top surface of plenums.
 - d. Do not over compress insulation during installation.

- e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
2. Install insulation with a continuous unbroken vapor barrier and insulation butted tight at each joint. Create a facing lap for longitudinal seams and end joints with insulation by removing up to 2 inches (50 mm) from one edge as required to allow stapling. Secure laps to adjacent insulation section with 1/2-inch (13 mm) outward-clinching staples, 6 inch (150 mm) (maximum) on center. Staples may be omitted when closures are made by machine using heat-sensitive tape. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 3. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) (maximum) on center.
- D. Duct Liner-Insulation Applied on the Interior of the Duct:
1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.
 2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.
 3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 2,000 fpm or higher, a metal nosing must be installed in all liner facing fan discharge or upstream of the airflow.
 4. Repair liner surface penetrations with UL listed adhesive.
 5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.
 6. Liner shall be folded and compressed into corners of rectangular duct or cut and fitted to assure a lapped compressed joint. Longitudinal joints should not occur in rectangular duct except at corners.
 7. Longitudinal joints shall be coated with adhesive.
- 3.03 ENCAPSULATING NON-RATED PIPES AND CABLES
- A. Where combustible non-fire rated pipes (plastic) and cables are installed in an air plenum space provide one layer of **FRI-E** fire barrier plenum wrap to fully encapsulate the item to comply with ASTM E84 or UL-723.
- 3.04 DUCTWORK INSULATION SCHEDULES

- A. All insulation thicknesses shall meet or exceed latest edition of applicable ASHRAE 90.1, IECC, State Energy Code, Local Energy Code, and State Mechanical Code requirements as noted below. Minimum thermal resistance in range of 4.0 to 4.2 per inch of thickness. Insulation thicknesses are based on glass mineral wool insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.
- B. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:
1. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
 2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
 3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.
- C. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms used as ducts or plenums, shall be installed, sealed, and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
1. Outdoors; or,
 2. In a space between the roof and an insulated ceiling; or,
 3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or,
 4. In an unconditioned crawlspace; or,
 5. In other unconditioned spaces; or,
 6. For buildings subject to compliance with the IECC in any location in Climate Zones 5 through 8 the insulation shall be 3” (R-12) minimum thickness for ductwork exterior to the building envelope.
- D. TABLE 1: DUCT WRAP INSULATION SERVICE, THICKNESS, AND MATERIAL TYPE REQUIRED.

TABLE 1: EXTERNAL DUCT WRAP INSULATION			
SYSTEM	R-Value (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Supply and/or return ductwork located outside to the building envelope.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Metal jacket or galvanized sheet metal sandwich (double wall). Refer to drawings. Alternate option: pre-insulated duct system, refer to Section 233113 Air Distribution.	DW-B, RB-A. Duct wrap or blanket with fabric jacket is not allowed.
Supply and/or return ducts within building envelope in unconditioned areas, inside shafts and above ceilings.	R-8	FSK or PSK	DW-A, B, C
Supply and/or return duct exposed in the atmosphere controlled occupied space.	R-4.2	Black PSK	DW-C
Supply or return duct serving the remote 50 ft. (15 m) of exposed ductwork in the atmosphere controlled occupied space.	NA	NA	Except where noted on drawings for acoustical reasons.
Outside air intake ducts within the building envelope.	R-4.2	FSK or PSK	DW-A, B
Exhaust ducts within 10 ft. (3 m) of exterior openings.	R-3	FSK or PSK	DW-A, B
Adjust insulation thicknesses as required to meet minimum R-Values.			

- E. TABLE 2: DUCTWORK RIGID INSULATION AND PLENUM INSULATION SERVICE, THICKNESS, AND INSULATION TYPE REQUIRED.

TABLE 2: RIGID INSULATION AND PLENUM INSULATION			
SYSTEM	THICKNESS (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Supply and/or return ducts located outside of the building envelope. Use rigid duct board sandwiched between sheet metal layers.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Metal jacket or galvanized sheet metal sandwich (double wall). Refer to drawings. Alternate option: pre-insulated duct system, refer to Section 233113 Air Distribution.	DW-B or RB-A. Duct wrap or blanket with fabric jacket are not allowed in this application.
Outside air intake ducts	R-4.2	FSK	RB-A. Provide aluminum jacket over exterior installations.
Interior Plenums	R-8	FSK	RB-A
Exterior Plenums	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	FSK	RB-A
Supply, return and relief ducts in mechanical rooms.	R-8	FSK	RB-A
Supply and return ducts routed through parking garages.	R-8	FSK	RB-A
Roof curb walls used for supply or return air that aren't pre-insulated by manufacturer.	R-8	FSK	RB-A
Roof surface inside roof curb perimeter and around duct penetrations.	R-8 or greater to match roof insulation value	FSK	RB-A

TABLE 2: RIGID INSULATION AND PLENUM INSULATION			
SYSTEM	THICKNESS (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Vapor/moisture ducts installed exterior to the building envelope.	R-4.2	FSK	RB-A. Provide jacketing on exterior ducts.
Adjust insulation thicknesses as required to meet minimum R-Values.			

F. TABLE 3: ACOUSTIC DUCT LINER SERVICE, THICKNESS, AND INSULATION TYPE
REQUIRED

TABLE 3: ACOUSTICAL DUCT LINER			
SYSTEM	THICKNESS (Minimum)	FINISH	INSULATION KEY CODE
Where indicated for rectangular supply or return ductwork installed in conditioned areas.	R-4.2 unless otherwise noted on drawings	Air stream side mat or other fiber-free facing	ADL-A, B, C
Where indicated for rectangular supply or return ductwork installed in unconditioned areas without exterior duct insulation.	R-8 unless otherwise noted on drawings	Air stream side mat or other fiber-free facing	ADL-A, B, C
Supply and/or return ducts located exterior to the building envelope, where indicated on drawing.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Air stream side mat or other fiber-free facing	ADL-A, B, C
Inside supply and return ducts within 20' of Air Handling Unit connections.	R-8	Air stream side mat or other fiber-free facing	ADL-A, B, C
VAV terminal unit outlet plenum	R-4.2 unless otherwise noted on drawings	Air stream side shall be fiber-free with resin mat facing, aluminum or mylar liner, or acrylic polymer facing	ADL-A, B, C
Where indicated for round ductwork installed in conditioned areas.	R-4.2	Air stream side mat or other fiber-free facing	ADL-D
Where indicated for round ductwork installed in unconditioned areas without exterior insulation.	R-8	Air stream side mat or other fiber-free facing	ADL-D
Adjust insulation thicknesses as required to meet minimum R-Values.			

END OF SECTION

SECTION 23 07 16

HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
1. HVAC Equipment Insulation section includes the following equipment that is not factory insulated
 - a. Heat exchangers.
 - b. Converters.
 - c. Chilled-water pumps.
 - d. Condenser-water pumps.
 - e. Heating hot-water pumps.
 - f. Heat-recovery pumps.
 - g. Steam condensate pumps.
 - h. Expansion/compression tanks.
 - i. Air separators.
 - j. Thermal storage tanks.
 - k. Deaerators.
 - l. Steam condensate tanks.
 - m. Steam flash tanks, flash separators, moisture separators, and blow-off tanks.
 - n. Piping system filtration unit housings.
 - o. Outdoor, aboveground, heated, fuel-oil storage tanks.
 - p. Generator exhaust systems.
- B. Types of mechanical insulation specified in this Section include the following:
1. Glass fiber and mineral wool.
 2. Closed cell phenolic.
 3. Polyisocyanurate.
 4. Calcium silicate.

5. Cellular glass.
6. Flexible elastomeric closed-cell foam.
7. Aerocel.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 22: Plumbing.
- B. Section 23 05 00 - Basic HVAC Materials and Methods.
- C. Section 23 21 13 - Hydronic Piping, Valves and Specialties.

1.04 DEFINITIONS

- A. Ambient: The air temperature to be maintained in a conditioned room. Typically, between 70°F and 78°F.
- B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
- C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
- D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
- E. Jacket: Protective covering over the pipe insulation; may be factory applied such as "all service jacket" or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
- F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
- G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
- H. Freezing Climate: Where outdoor design temperature is less than 33° F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.
- I. Unconditioned Space: any space not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.05 INSULATION INDUSTRY DEFINITIONS

- A. UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
- B. EPA: Environmental Protection Agency.
- C. WHO: World Health Organization.
- D. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.

- E. ASJ: All Service Jacket (no outer film).
- F. SSL+: Self-Sealing Lap with Advanced Closure System.
- G. SSL: Self-Sealing Lap.
- H. FSK: Foil Scrim Kraft; jacketing.
- I. FSP: Foil Scrim Polyethylene jacketing
- J. PSK: Poly Scrim Kraft; jacketing.
- K. PVC: Polyvinyl Chloride.
- L. FHC: Fire Hazard Classification
- M. Glass Mineral Wool: Interchangeable with fiber glass, but replacing the term in the attempt to disassociate and differentiate Glass Mineral Wool from the potential health and safety risk of special purpose or reinforcement products that do not meet the bio solubility criteria of insulation made from glass. Rock Mineral Wool will replace the traditional Mineral Wool label. Both are used in lieu of the Mineral Fiber label.
- N. ECOSE Technology: a proprietary binder system based on rapidly renewable bio-based materials; rather than petroleum-based chemicals commonly used in other glass mineral wool insulation materials. ECOSE Technology reduces the binder embodied energy by up to 70 percent and does not contain phenol, formaldehyde, acrylics or artificial colors.
- O. UL GREENGUARD Gold Certification: (formerly known as GREENGUARD Children & Schools Certification) offers stricter certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by both The Collaborative for High Performance Schools (CHPS) and the Leadership in Energy Environmental Design (LEED) Building Rating Systems.
- P. Recycled Content – Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product rather than being placed in a landfill or incinerated.
- Q. Recycled Content – Pre-Consumer (aka Post-Industrial): materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.
- R. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE and Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.
- S. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to applicable UL requirements standards for safety and standards of other National and International organizations
- T. Imperative 11, Red List – requires that manufacturers disclose the ingredients in their products to confirm they are free of Red List chemicals and materials. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.

- U. Underwriter's Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification.
- V. UL Environment Claims Validation (ECV): service and label tests a manufacturer's product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service enables products to qualify for LEED® MR Credit 4 Recycled Content LEED-NC 2009 or New LEED V-4 Building product disclosure and optimization – sourcing of raw materials.

1.06 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
 - 1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
 - a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
 - b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
 - c. C168 – Terminology for Thermal Insulation
 - d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
 - e. Properties by Means of the Guarded-Hot-Plate Apparatus.
 - f. C195 - Specification for Mineral Fiber Thermal Insulating Cement.
 - g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
 - h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
 - i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
 - j. C305 - Test for Thermal Conductivity of Pipe Insulation.
 - k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
 - l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
 - m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - n. C449 - Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - o. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
 - s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
 - t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).

- u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
 - v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
 - w. C795 – Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals.
 - x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
 - y. C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - z. C1071 - Standard Specification for Thermal and Acoustical Insulation.
 - aa. C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - bb. C1617 Standard Specification for Thermal Insulation for use in Contact with Austenitic Stainless Steel.
 - cc. D1667 – Standard Specification for Flexible Cellular Material-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
 - dd. E84 - Test Method for Surface Burning Characteristics of Building Materials.
 - ee. E119 - Test for Fire Resistance.
 - ff. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - gg. G22 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
- a. 90 - Energy Conservation in New Building Design.
3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
- a. 255 - Test Methods, Surface Burning Characteristics of Building Materials.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.
- D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

- E. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
1. Test Specimen: Two specimens shall be used, each measuring 1" by 4" by approximately 1/2" thick.
 2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1" wide, 4" long and 0.020" thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lbs./sq. ft.
 3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.
- F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.
- G. Sustainable Project Requirements:
1. Formaldehyde Free: Third party certified with UL Environment Validation or Scientific Certification Systems (SCS).
 2. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).
 3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of UL GREENGUARD standards for Low-Emitting Products.
 4. Living Building Challenge-Declare Red List Free.

1.07 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
1. Pentabrominated diphenyl ether (CAS#32534-81-9)
 2. Octabrominated diphenyl ether (CAS#32536-52-0)
 3. Decabrominated diphenyl ether (CAS#1163-19-50)
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.08 LEED ACTION SUBMITTALS:

- A. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
 - B. Product Data for Credit MR 5 Regional Materials: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
 - C. LEED v 4, Product Data for Credit EA 2: For products and materials significant to the energy performance of a structure, provide documentation that indicates that insulation levels are significant to increasing the level of energy performance beyond the prerequisite standard.
 - D. LEED v 4, Product Data for Credit MR 2: For products and materials to comply with Building Product Disclosure & Optimization, provide data/evidence that substantiates Environmental Product Declaration and Multi Attribute Optimization requirements.
 - E. LEED v 4: Product Data for Credit MR 3: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
 - F. LEED v 4, Product Data for Credit MR 4: For products having recycled content documentation; indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
 - G. LEED v 4, Product Data for Credit EQ 2: For products and materials to comply with low emittance standards, provide documentation substantiating that insulation products comply with requisite low emittance standards.
 - H. LEED v 4, Product Data for Credit EQ 5: For products and materials to meet the standard for both thermal comfort design and thermal comfort control, provide data to support that insulation products are significant to thermal comfort design and thermal comfort control.
 - I. LEED v 4, Product Data for Credit EQ 9: For products and materials that contribute to the design and performance of workspaces that promote occupants well-being, productivity, and communication, provide data/documentation supporting acoustical benefits of Glass Mineral Wool insulation products.
 - J. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 1.09 DELIVERY, STORAGE, AND HANDLING
- A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
 - B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.
- 1.10 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Comply with requirements in "PART 3-EXECUTION, Table 1: Equipment Insulation Type Required" for application of insulating materials. Products shall not contain asbestos, lead, mercury or mercury compounds if possible. Products shall be certified UL GREENGUARD Gold or Indoor Advantage Gold if possible.
- B. Products that contact stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Each insulation material has been provided a descriptive key code, such as EI-A, to simplify the organization and application of materials in following sub-sections.
- F. Acceptable manufacturers include Knauf, Johns Manville, Owens-Corning, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, Aeroflex, Armacell, Pacor or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.02 EQUIPMENT INSULATION (IDENTIFIED BY KEY CODE EI AND IN TABLE 1)

- A. **EI-A, Rigid Hydrous Calcium Silicate:**
 - 1. Applications: High temperature insulation for piping and equipment and for placement at piping hangers and supports.
 - 2. Compliant with ASTM C165, C302, C356, C447, C533, C665, C1338 and E84.
 - 3. Maximum Service Temperature: 1200°F (650°C).
 - 4. Thermal conductivity (K-value): 0.389 Btu□in./(hr□ft²□°F), or less, at 200°F (93°C). Thickness as required to meet energy code requirements.
 - 5. Nominal density is 14 lbs./cu. ft. or greater.
 - 6. Compressive Strength (block): Minimum of 100 psi to produce 5% compression as tested per ASTM C165.
 - 7. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =0 ratings as tested per ASTM E84.
 - 8. Tie Wire: 16-gauge stainless steel with twisted ends on maximum 12" centers.
 - 9. Product must contain corrosion inhibiting chemistry.
 - 10. Manufacturers: Johns Manville Industrial Insulation Group #Thermo-12 Gold or equal.

B. EI-B, Rigid Closed-Cell Cellular Glass:

1. Applications: Rigid closed cell glass impermeable to water and water vapor for insulating buried piping and equipment, as well as traditional application on other piping and equipment.
2. Compliant with ASTM C165, C240, C303, C450, C552, C585, E136, E1461, and E84.
3. Service Temperature Range: -450°F to 900°F (-268°C to 482°C).
4. Thermal conductivity (K-value): 0.29 Btu·in./(hr·ft²·°F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
5. Water Vapor Absorption, % of volume: <0.2% (maximum) compliant with ASTM C240.
6. Nominal density is 8 lbs./cu. ft. or greater.
7. Compressive Strength (block): Minimum of 90 psi to produce 5% compression as tested per ASTM C165.
8. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =0 ratings as tested per ASTM E84.
9. Manufacturers: Pittsburgh-Corning #Foamglas One or equal

C. EI-C, Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene:

1. Applications: Insulation of piping, fittings and equipment with thickness as required by local energy code.
2. Compliant with UL 181, ASTM C411, C518, C534, G21/C1338, G22, D1056 and E84. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
3. Service Temperature Range: -297°F to 220°F (-183°C to 105°C).
4. Thermal conductivity (K-value): 0.28 Btu·in./(hr·ft²·°F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
5. Water Vapor Absorption, % of volume: <0.2% (maximum) compliant with ASTM C209.
6. Nominal density is 2.5 lbs./cu. ft. or greater.
7. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
8. Seal all seams and joints with contact adhesive or factory self-seal system with lap seal tape.
9. Manufacturers: Armacel #AP Armaflex, Rubatex #K-Flex ECO, Aeroflex #Aerocel or equal.

D. EI-D, Rigid Fiberglass Board:

1. Applications: Rigid fiberglass insulation board for insulation of ducts and plenums, tanks, and walls with integral vapor barrier. Thickness as required by local energy code. Insulation shall be provided with a jacket coordinated with the temperature service of the insulation. Glass fibers bonded with a thermosetting resin.
2. Compliant with ASTM C423, C553, C612, C665, C1101, C1136, C1338, E795 and E84.
3. Thermal conductivity (K-value): 0.25 Btu·in./(hr·ft²·°F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
4. Service Temperature Range: 0°F to 250°F (-18°C to 121°C) for faced board.
5. Water Vapor Absorption, % of volume: <5% (maximum) as tested per ASTM C1104.

6. Vapor Retarder Jacket: Factory applied ASJ or FSK interleaving reinforced with glass fiber scrim yarn and bonded to aluminum foil.
 7. Nominal density is 2.0 lbs./cu. ft. or greater.
 8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 9. Manufacturers: CertainTeed #CertaPro Commercial Board, Johns Manville #800 Series Spin-Glas, Knauf, Manson, Owens Corning or equal.
- E. **EI-E**, Flexible Fiberglass Blanket:
1. Applications: Flexible insulation blanket for wrapping large pipes, tanks and equipment. Thickness as required by local energy code. Insulation shall be provided with a jacket coordinated with the temperature service of the insulation. Glass or mineral fibers bonded with a thermosetting resin.
 2. Compliant with ASTM C167, C177, C411, C518, C612, C665, C1136, C1338, C1393, E96 and E84.
 3. Thermal conductivity (K-value): 0.24 Btu \cdot in./(hr \cdot ft 2 \cdot °F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 4. Service Temperature Range: 35°F to 850°F (2°C to 454°C).
 5. Water Vapor Absorption, % of volume: <5% (maximum) as tested per ASTM C1104.
 6. Vapor Retarder Jacket: Factory applied ASJ or FSK interleaving reinforced with glass fiber scrim yarn and bonded to aluminum foil.
 7. Nominal density is 2.5 lbs./cu. ft. or greater.
 8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 9. Manufacturers: CertainTeed #CrimpWrap, Johns Manville #Micro-Flex, Knauf, Manson, Owens Corning or equal.
- F. **EI-F**, Rigid High Temperature Mineral Fiber Board:
1. Applications: Rigid high temperature insulation board for insulation of equipment and tanks with thickness as required by local energy code. Insulation shall be provided with a jacket coordinated with the temperature service of the insulation. Inorganic mineral fibers bonded with a thermosetting resin.
 2. Compliant with ASTM C356, C447, C612, C665, C692, C795, C871, C1104 and E84.
 3. Thermal conductivity (K-value): 0.25 Btu \cdot in./(hr \cdot ft 2 \cdot °F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 4. Service Temperature Range: 0°F to 1200°F (-18°C to 650°C).
 5. Water Vapor Absorption, % of volume: <1% (maximum) as tested per ASTM C1104.
 6. Nominal density is 6 lbs./cu. ft. or greater.
 7. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 8. Manufacturers: Johns Manville #MinWool-1260, Owens Corning Thermafiber #Industrial Board, Johns Manville, Knauf, Manson, Rockwool, CertainTeed or equal.
- G. **EI-G**, Flexible High Temperature Mineral Fiber Blanket:

1. Applications: Flexible high temperature insulation blanket for tanks and equipment with thickness as required by local energy code. Insulation shall be provided with a jacket coordinated with the temperature service of the insulation. Inorganic mineral fibers bonded with a thermosetting resin.
 2. Compliant with ASTM C356, C447, C612, C665, C692, C795, C871, C1104 and E84.
 3. Thermal conductivity (K-value): 0.25 Btu□in./(hr□ft²□°F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 4. Service Temperature Range: 0°F to 1200°F (-18°C to 650°C).
 5. Water Vapor Absorption, % of volume: <1% (maximum) as tested per ASTM C1104.
 6. Nominal density is 6 lbs./cu. ft. or greater.
 7. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
 8. Manufacturers: Owens Corning Thermafiber #Industrial Blanket, Johns Manville, Knauf, Manson, Rockwool, CertainTeed or equal.
- H. **EI-H**, Rigid Closed-Cell Phenolic Foam:
1. Applications: Insulation of piping, tanks, and equipment with thickness as required by local energy code.
 2. Compliant with ASTM C209, C518, C795, C1126, D1621, D1622, D2856, D6226 and E84.
 3. Service Temperature Range: -290°F to 250°F (-178°C to 121°C).
 4. Thermal conductivity (K-value): 0.18 Btu□in./(hr□ft²□°F) or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 5. Vapor Retarder Jacket – straight sections: Factory applied ASJ with SSL.
 6. Water Vapor Absorption, % of volume: <0.87% (maximum) as tested per ASTM C209.
 7. Nominal density is 2.5 lbs./cu. ft. or greater.
 8. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
 9. Manufacturers: ITW Trymer #Supercel, Kingspan #Koolphen K, Resolco #Insul-phen or equal.
- I. **EI-I**, Rigid Closed-Cell Polyisocyanurate Foam:
1. Applications: Rigid preformed insulation of piping, fittings, vessels, and equipment with thickness as required by local energy code. Not for use in return air plenums or ventilation ductworks.
 2. Compliant with ASTM C272, C591, C755, C1136, C920, D6226, E96, and E84.
 3. Service Temperature Range: -297°F to 300°F (-183°C to 149°C).
 4. Thermal conductivity (K-value): 0.19 Btu□in./(hr□ft²□°F) or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 5. Water Absorption, % of volume: 0.7 (maximum) as tested per ASTM C272.
 6. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.
 7. Nominal density is 2 lbs./cu. ft. or greater.

8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 450 ratings as tested per ASTM E84. Not compliant for use in return air plenums.
 9. Manufacturers: Trymer #2000 XP, Dyplast #ISO, HiTherm or equal.
- J. **EI-J**, Rigid Extruded Polystyrene Foam Board:
1. Applications: Rigid board insulation for large outdoor tanks and vessels with thickness as required by local energy code. Not for use indoors.
 2. Compliant with ASTM C203, C272, C518, C578, D121, D696, D1621, D2126, D2842 and E96.
 3. Maximum Service Temperature: 165°F (75°C).
 4. Thermal conductivity (K-value): 0.18 Btu \cdot in./(hr \cdot ft 2 \cdot °F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 5. Water Vapor Absorption, % of volume: $< 0.2\%$ (maximum) compliant with ASTM C209.
 6. Nominal density is 2.5 lbs./cu. ft. or greater.
 7. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =155 ratings as tested per ASTM E84.
 8. Seal all seams and joints with contact adhesive and provide field applied jacket system.
 9. Manufacturers: Dow #Styrofoam or equal.
- K. **EI-K**, Flexible Low Temperature Aerogel (Cold Fluid Piping and Equipment):
1. Applications: High performance flexible insulation for specialty insulation of low temperature piping and equipment with reduced available space or where higher thermal performance is required.
 2. Compliant with ASTM C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763 and E84.
 3. Service Temperature Range: -200°F to 200°F (-129°C to 93°C).
 4. Thermal conductivity (K-value): 0.12 Btu \cdot in./(hr \cdot ft 2 \cdot °F), or less, at 75°F (24°C). Thickness as required to meet energy code requirements.
 5. Water Vapor Absorption, % of volume: $\leq 5\%$ (maximum) as tested per ASTM C1104 compliant with ASTM C240.
 6. Nominal density is 10 lbs./cu. ft. or greater.
 7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
 8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 9. Manufacturers: Pacor #Cryogel X201 or equal.
- L. **EI-L**, Flexible High Temperature Aerogel (Hot Fluid Piping and Equipment):
1. Applications: High performance flexible insulation for specialty insulation of high temperature piping and equipment with reduced available space or where higher thermal performance is required.
 2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
 3. Service Temperature Range: 32°F to 482°F (0°C to 250°C).

4. Thermal conductivity (K-value): 0.12 Btu·in./(hr·ft²·°F), or less, at 212°F (100°C). Thickness as required to meet energy code requirements.
5. Water Vapor Absorption, % of volume: ≤5% (maximum) as tested per ASTM C1104 compliant with ASTM C240.
6. Nominal density is 10 lbs./cu. ft. or greater.
7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
8. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
9. Manufacturers: Pacor #Pryogel 2250.

M. **EI-M**, Flexible Extreme High Temperature Aerogel (High Temperature Exhaust Piping and Equipment):

1. Applications: High performance flexible insulation for specialty insulation of extreme high temperature piping and equipment with reduced available space or where higher thermal performance is required.
2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
3. Service Temperature Range: 32°F to 1200°F (0°C to 650°C).
4. Thermal conductivity (K-value): 0.16 Btu·in./(hr·ft²·°F), or less, at 212°F (100°C). Thickness as required to meet energy code requirements.
5. Water Vapor Absorption, % of volume: ≤5% (maximum) as tested per ASTM C1104 compliant with ASTM C240.
6. Nominal density is 12.5 lbs./cu. ft. or greater.
7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
8. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
9. Manufacturers: Pacor #Pryogel XTE.

2.03 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ+: White, polypropylene-coated, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
3. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
4. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
5. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.04 JACKETING MATERIALS

A. Field Applied Jackets (For Indoor Applications):

1. All longitudinal seams shall be located on bottom of pipes.
2. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
3. PVC Plastic:
 - a. High-impact-resistant, UV-resistant PVC as tested per ASTM C553, C547, C665, C795, C1338, D1784, E96, C1136 and D3679.
 - b. One piece molded type fitting covers and jacketing material.
 - c. Adhesive: As recommended by jacket material manufacturer.
 - d. Color: White.
 - e. Thickness: 20 mil (0.5 mm), minimum.
 - f. Service Temperature Range: 0°F to 150°F (-18°C to 66°C).
 - g. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 - h. Manufacturers: Johns Manville #Zeston 2000, Proto #LoSmoke, PIC Plastics, Proto Corporation, Speedline Corporation or equal.
4. Aluminum Jacket:
 - a. Comply with ASTM B209/B209M.
 - b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
 - c. Thickness: 0.016" thick sheet (minimum).
 - d. Finish: Smooth or stucco embossed
 - e. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - f. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - g. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 - h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
5. Canvas Jacket:
 - a. Cotton or fiberglass cloth.
 - b. UL listed fabric treated with dilute fire retardant.
 - c. Lagging adhesive per manufacturer.
 - d. Manufacturers: GJC General, GLT Products, Foster #Mast-A-Fab, Childers #Chil-Glas No. 5 or equal.

B. Field Applied Jackets (For Outdoor Applications): All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.

1. Secure stainless steel or aluminum jackets with 3/8" or 1/2" stainless steel bands on 12" centers and at each joint.
2. PVC Jacket: Not allowed for outdoor applications.
3. Canvas Jacket: Not allowed for outdoor applications.

4. Aluminum Jacket:
 - a. Comply with ASTM B209/B209M.
 - b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
 - c. Thickness: 0.016" thick sheet (minimum).
 - d. Finish: Smooth, stucco embossed or corrugated surface.
 - e. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - f. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - g. Manufacturers: Pabco, Childers, RPR, ITW or equal.
 5. Self-Adhesive Aluminum Jacket:
 - a. Comply with ASTM D774, C1338, C1371, E96, and D882.
 - b. Thickness: 56 mils (minimum).
 - c. Multi-ply UV-resistant aluminum foil/polymer laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
 - d. Weight: 0.3 lbs./sf, minimum.
 - e. Service Temperature Range: -15°F to 160°F (-26°C to 71°C).
 - f. Manufacturers: Polyguard Products #Alumaguard or equal.
 6. Stainless Steel Jacket:
 - a. Comply with ASTM A240 and A666.
 - b. Stainless steel alloy T-304 or T-316. T-316 shall be used in corrosive environments including close proximity to coast.
 - c. Thickness: 0.016" thick sheet (minimum).
 - d. Dull Finish: Smooth, stucco embossed or corrugated surface.
 - e. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - f. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - g. Manufacturers: Pabco, Childers, RPR, ITW or equal.
- C. Removable Covers:
1. Provide removable covers on indoor pumps, valves, air separators, air vent fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation is required.
 - a. Pre-molded insulation covers:
 - 1) Cold Systems: Provide PVC covers over insulated elbows, fittings and flanges.
 - 2) Cold Systems: Provide flexible closed cell foam or removable cloth insulating blankets for valves, pumps and strainers.
 - 3) Hot Systems: Provide PVC covers over insulated elbows, fittings and flanges.

- 4) Hot Systems: Provide removable cloth insulating blankets on valves, pumps, and strainers.
- b. Removable cloth insulating blankets:
- 1) Service Operating Temperature: 0-350°F.
 - 2) Jacket and Liner: silicon or teflon impregnated mineral wool cloth.
 - 3) Liner Reinforcement: stainless steel mesh cloth.
 - 4) Insulation: Fiberglass matt or Pacor #Aerogel, 2" thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
 - 5) Fastening: 2" Nomex Velcro or 1" straps and stainless steel D-rings or 12-gage stainless steel hooks and stainless steel wire.
 - 6) Thread: Kevlar/stainless steel thread.
 - 7) Outdoor Applications: Jacket shall be UV and ozone resistant with Velcro attachment.
 - 8) Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, Alpha or equal.

2.05 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch (1.0 mm thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304

2.06 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive:
 1. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 1200°F (10 to 649°C).
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Childers Brand #CP-97, Johns Manville #CalBond Gold, Marathon Industries #290, Foster Brand #81-27, Mon-Eco Industries #22-30, Vimasco Corporation #760 or equal.
- C. Cellular-Glass Adhesive:
 1. Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200°F (minus 73 to plus 93°C).
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Foster Brand #81-84 or equal.

- D. Phenolic and Polyisocyanurate Adhesive:
1. Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300°F (minus 59 to plus 149°C).
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Childers Brand #CP-96, Foster Brand #81-33 or equal.
- E. Flexible Elastomeric and Polyolefin Adhesive:
1. Comply with MIL-A-24179A, Type II, Class I.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Aeroflex USA, Inc.; Aeroseal, Armacell LLC; Armaflex #520 Adhesive, Foster Brand #85-75, K-Flex USA #R-373 Contact Adhesive or equal.
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Childers Brand #CP-127, Eagle Bridges - Marathon Industries #225, Foster Brand #85-60/85-70, Mon-Eco Industries, Inc.#22-25 or equal.
- G. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Childers Brand #CP-82, Eagle Bridges - Marathon Industries #225, Foster Brand #85-50, Mon-Eco Industries, Inc.#22-25 or equal.
- H. PVC Jacket Adhesive: Compatible with PVC jacket.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Dow Corning Corporation #739, Dow Silicone, Johns Manville #Zeston Perma-Weld, CEEL-TITE #Solvent Welding Adhesive, P.I.C. Plastics, Inc. #Welding Adhesive, Speedline Corporation #Polyco VP Adhesive or equal.

2.07 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based for indoor use.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43 mil (1.09 mm) dry film thickness.
 2. Service Temperature Range: -20°F to 180°F (-29 to 82°C).
 3. Vapor Safe Coating: Shall meet requirements of LEED IEQ Low-Emitting Materials. VOC 33 g/l, less water and exempt solvents.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.
6. Manufacturers: Foster Brand #30-80/30-90, Vimasco Corporation #749 or equal.

C. Vapor-Barrier Mastic: Solvent based for outdoor use.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30 mil (0.8 mm) dry film thickness.
2. Service Temperature Range: -50°F to 220°F (-46 to 104°C).
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.
5. Manufacturers: Childers Brand #Encacel X CP-40, Eagle Bridges - Marathon Industries #570, Foster Brand #60-95/60-96 or equal.

D. Breather Mastic: Water based for indoor and outdoor use.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625 inch (1.6 mm) dry film thickness.
2. Service Temperature Range: -20°F to 180°F (-29 to 82°C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.
5. Manufacturers: Childers Brand #CP-10/CP-11, Eagle Bridges - Marathon Industries #550, Foster Brand #46-50, Mon-Eco Industries, Inc. #55-50, Vimasco Corporation #WC-1/WC-5 or equal.

2.08 LAGGING ADHESIVES

A. Adhesives shall be compatible with insulation materials, jackets, and substrates.

1. Comply with MIL-A-3316C, Class I, Grade.
2. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to 180°F (-18 to 82°C).
5. Color: White.
6. Manufacturers: Childers Brand #CP-50 AHV2, Foster Brand #30-36, Vimasco Corporation #713/714 or equal.

2.09 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate.
 - a. Manufacturers: Childers Brand #CP-76, Marathon Industries#405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05, Pittsburgh Corning Corporation #Pittseal 444 or equal.
2. Joint Sealants for Polystyrene.

- a. Manufacturers: Childers Brand #CP-70, Marathon Industries #405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05 or equal.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: -100 to 300°F (-73 to 149°C).
 6. Color: White or gray.
 7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Shall be compliant with requirements of LEED IEQ Low-Emitting Materials.
- B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
 4. Color: Aluminum.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 6. Manufacturers: Childers Brand #CP-76, Eagle Bridges - Marathon Industries #405, Foster Brand #95-44, Mon-Eco Industries, Inc. #44-05 or equal.
- C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
 4. Color: White.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 6. Manufacturers: Childers Brand #CP-76 or equal.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 11.5 mils (0.29 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
 7. Manufacturers: ABI, Ideal Tape Division #428 AWF ASJ, Avery Dennison Corporation #Fasson 0836, Compac Corporation #105, 3M Venture Tape #1540 CW Plus/1542 CW Plus/1542 CW Plus/SQ or equal.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 6.5 mils (0.16 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
 7. Manufacturers: ABI Tape #491 AWF FSK, Avery Dennison Corporation #Fasson 0827, Compac Corporation #110 and 111, 3M Venture Tape #1525 CW NT/1528 CW/1528 CW/SQ or equal.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
 2. Thickness: 6 mils (0.15 mm).
 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
 6. Manufacturers: ABI Tape #370 White PVC tape, Compac Corporation #130, Venture Tape #1506 CW NS or equal.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
 6. Manufacturers: ABI Tape #488 AWF, Avery Dennison Corporation #Fasson 0800, Compac Corporation #120, 3M Venture Tape #3520 CW or equal.

2.11 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304, 0.020 inch (0.50 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
 2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal
springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application. Manufacturers: ITW Insulation Systems, Gerrard, RPR or equal.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins:

- a. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - b. Manufacturers: AGM Industries #CWP-1, GEMCO #CD, Midwest Fasteners #CD, Nelson Stud Welding #TPA/TPC/TPS or equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins:
- a. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38 mm) galvanized carbon-steel washer.
 - b. Manufacturers: AGM Industries #CHP-1, GEMCO #Cupped Head Weld Pin, Midwest Fasteners #Cupped Head, Nelson Stud Welding #CHP or equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers:
- a. Baseplate welded to projecting spindle capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel coordinated with application, fully annealed, 12 gauge, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - e. Manufacturers: AGM Industries, Inc. #Tactoo Perforated Base Insul-Hangers, GEMCO #Perforated Base, Midwest Fasteners #Spindle or equal.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers:
- a. Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - c. Spindle: Nylon, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
 - d. Adhesive as recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - e. Manufacturers: GEMCO #Nylon Hangers, Midwest Fasteners #Nylon Insulation Hangers or equal.
5. Self-Sticking-Base Insulation Hangers:
- a. Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, as coordinated with application. 12 gauge, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.

- d. Adhesive-backed base with a peel-off protective cover.
 - e. Manufacturers: AGM Industries, Inc. #Tactoo Self-Adhering Insul-Hangers, GEMCO #Peel & Press, Midwest Fasteners #Self Stick equal.
6. Insulation-Retaining Washers:
- a. Self-locking washers formed from 0.015 inch (0.41 mm) thick, galvanized-steel, aluminum or stainless steel sheet, as coordinated with application with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - c. Manufacturers: AGM Industries #RC-150, GEMCO #R-150, Midwest Fasteners #WA-150, Nelson Stud Welding #Speed Clips or equal.
7. Nonmetal Insulation-Retaining Washers:
- a. Self-locking washers formed from 0.016 inch (0.41 mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - b. Manufacturers: GEMCO, Midwest Fasteners or equal.
- C. Staples: Outward-clinching insulation staples, nominal 0.75 inch (19 mm) wide, stainless steel or Monel.
- D. Wire: 0.062 inch (1.6 mm) soft-annealed, stainless steel.
- 1. Manufacturers: C&F Wire Products or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature ranging from 140°F to 300°F (60°C to 149°C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature ranging from 32°F to 300°F (0°C to 149°C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3" (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) on center.
 3. Overlap jacket longitudinal seams at least 1-1/2" (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2" (50 mm) on center. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4" (100 mm) beyond damaged areas. Adhere, staple, and seal patches like butt joints.
- O. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16" (400 mm) on center in both directions.
 - d. Do not over compress insulation during installation.

- e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles or breather springs. Place one circumferential girdle around equipment approximately 6" (150 mm) from each end. Install wire or cable between two circumferential girdles 12" (300 mm) on center. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48" (1200 mm) on center. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3" (75 mm).
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6" (150 mm) centers, starting at corners. Install 3/8" (10 mm) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from galvanized steel, aluminum or stainless steel, at least 0.040 inch (1.0 mm) thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- 3.05 INSTALLATION OF CALCIUM SILICATE INSULATION
- A. Insulation Installation on Boiler Breechings:
1. Secure single-layer insulation with stainless-steel bands at 12" (300 mm) intervals and tighten bands without deforming insulation material.

2. Install two-layer insulation with joints tightly butted and staggered at least 3" (75 mm). Secure inner layer with wire spaced at 12" (300 mm) intervals. Secure outer layer with stainless-steel bands at 12" (300 mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1" (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.06 INSTALLATION OF PHENOLIC INSULATION

- A. Secure single-layer insulation with stainless-steel bands at 12" (300 mm) intervals and tighten bands without deforming insulation materials.
- B. Install two-layer insulation with joints tightly butted and staggered at least 3" (75 mm). Secure inner layer with 0.062" (1.6 mm) wire spaced at 12" (300 mm) intervals. Secure outer layer with stainless-steel bands at 12" (300 mm) intervals.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2" (50 mm) overlap at seams and joints.
 2. Embed glass cloth between two 0.062" (1.6 mm) thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2" (38 mm) laps at longitudinal seams and 3" (75 mm) wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1" (25 mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2" (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12" (300 mm) on center and at end joints.
- E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference less than 34" (860 mm). A 34" (860 mm) circumference limit allows for 2" (50 mm) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 125% circumferences to avoid damage to tape edges.

3.08 FINISHES

- A. Equipment Insulation with ASJ+, Glass-Cloth or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 for Sections "Exterior Painting" and "Interior Painting".
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

3.09 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. TABLE 1: EQUIPMENT INSULATION TYPE REQUIRED.
 1. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness by 1/2" (minimum) where insulated pipe is exposed to exterior ambient air. Minimum thermal resistance shall comply with building code minimum ranges and may exceed those minimum levels. Insulation thicknesses may be adjusted for equivalent insulation values for materials with superior "K" factors. Refer to "PART 2- PRODUCTS" for characteristics of each insulation material listed below.

EQUIPMENT INSULATION INDEX	
INSULATION KEY CODE	INSULATION TYPE
EI-A	Rigid Hydrous Calcium Silicate
EI-B	Rigid Closed-Cell Cellular Glass
EI-C	Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene
EI-D	Rigid Fiberglass Board
EI-E	Flexible Fiberglass Blanket
EI-F	Rigid High Temperature Mineral Fiber Board
EI-G	Rigid High Temperature Mineral Fiber Blanket
EI-H	Rigid Closed-Cell Phenolic Foam
EI-I	Rigid Closed-Cell Polyisocyanurate Foam
EI-J	Rigid Extruded Polystyrene Foam Board
EI-K	Flexible Low Temperature Aerogel
EI-L	Flexible High Temperature Aerogel
EI-M	Flexible Extreme High Temperature Aerogel

TABLE 1: EQUIPMENT INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes, equipment, fittings, valves, etc. at pipe hangers and supports with saddles or 360° shields.	EI-A	Same thickness as adjoining pipe insulation
Chiller cold surfaces: condenser, evaporator, heat recovery bundles, suction piping, compressor inlets, water boxes, and nozzles.	EI-C,D,F,H,I	1" (25 mm)
	EI-C,D,F,H,I	1" (25 mm)

TABLE 1: EQUIPMENT INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes, equipment, fittings, valves, etc. at pipe hangers and supports with saddles or 360° shields.	EI-A	Same thickness as adjoining pipe insulation
Heat exchanger for cooling service.	EI-K	0.6" (15 mm)
Heat exchanger for heating service.	EI-D,F,H,I	3" (75 mm)
	EI-L	1.5" (38 mm)
Steam to hot water converter.	EI-D,F	4" (100 mm)
	EI-L	2" (50 mm)
Chilled water pump.	EI-C,D,F,H,I	1" (25 mm)
	EI-K	0.6" (15 mm)
Condenser water pump (outdoors).	EI-C,D,F,H,I	1" (25 mm)
	EI-K	0.6" (15 mm)
Heating hot water pump.	EI-D,F,H,I	3" (75 mm)
	EI-L	1.5" (38 mm)
Heat recovery pump.	EI-D,F,H,I	2" (50 mm)
	EI-L	1" (25 mm)
Chilled water expansion/compression tank.	EI-C,D,E,F,G,H,I	1" (25 mm)
	EI-K	1/2" (12 mm)
Condenser water expansion/compression tank.	EI-C,D,E,F,G,H,I	1" (25 mm)
	EI-K	1/2" (12 mm)
Hot water expansion/compression tank.	EI-C,D,E,F,G,H,I	1" (25 mm)
	EI-K	1/2" (12 mm)

TABLE 1: EQUIPMENT INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes, equipment, fittings, valves, etc. at pipe hangers and supports with saddles or 360° shields.	EI-A	Same thickness as adjoining pipe insulation
Heat recovery system expansion/compression tank.	EI-C,D,E,F,G,H,I	1" (25 mm)
	EI-K	1/2" (12 mm)
Chilled and condenser water air separator	EI-C,D,E,F,G,H,I	1" (25 mm)
	EI-K	0.6" (15 mm)
Heating water air separator.	EI-C,D,E,F,G,H,I	3" (75 mm)
	EI-L	1.5" (38 mm)
Cold thermal storage tank (indoors).	EI-C,D,E,F,G,H,I	3" (75 mm)
	EI-K	1.5" (38 mm)
Cold thermal storage tank (outdoors).	EI-H,I,J	3" (75 mm)
	EI-K	1.5" (75 mm)
Deaerator.	EI-D,E,F,G,H,I	3" (75 mm)
	EI-L	1.5" (38 mm)
Steam condensate pump and boiler feedwater pump.	EI-D,E,F,G,H,I	3" (75 mm)
	EI-L,M	1.5" (38 mm)
Steam condensate tank and receiver.	EI-D,E,F,G,H,I	3" (75 mm)
	EI-L,M	1.5" (38 mm)
Steam flash tank, flash separator, moisture separator, blow off tank.	EI-D,E,F,G,H,I	3" (75 mm)
	EI-L,M	1.5" (38 mm)
Outdoor, aboveground, heated, fuel-oil storage tank.	EI-B	3" (75 mm)
	EI-D,E,F,G,H,I	2" (50 mm)

TABLE 1: EQUIPMENT INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes, equipment, fittings, valves, etc. at pipe hangers and supports with saddles or 360° shields.	EI-A	Same thickness as adjoining pipe insulation
	EI-J	1.5" (38 mm)
Buried cold water piping and tanks.	EI-B	2" (50 mm)
Breeching, flues and connectors.	EI-A	4" (100 mm). Thickness is based on desired exterior temperature defined by code.
	EI-F,G	3" (75 mm)
	EI-L,M	2" (50 mm)
Generator engine exhaust piping, including flanges, fittings, mufflers, filters, etc.	EI-A	4" (100 mm). Thickness is based on desired exterior temperature defined by code.
	EI-O	2" (50 mm)
Generator engine exhaust flexible piping fittings	EI-G	3" (75 mm)
	EI-M	2" (50 mm)

3.10 EQUIPMENT INSULATION JACKET SCHEDULE

A. All insulation jackets shall be applied to protect the underlying insulation as scheduled above, providing protection both from environmental and physical conditions.

B. TABLE 2: INDOOR FIELD APPLIED EQUIPMENT INSULATION JACKETS

TABLE 2: INDOOR EQUIPMENT FIELD APPLIED INSULATION JACKET				
SERVICE	JACKET TYPE	THICKNESS OPTIONS	FINISH OPTIONS	CORRUGATION OPTIONS
Concealed equipment.	PVC	20 or 30 mils		
	Aluminum	0.016, 0.020, 0.024 or 0.032 inch	Smooth, corrugated, embossed	
	Stainless Steel	0.010, 0.016, 0.020, 0.024 inch	Smooth, corrugated, embossed	
Exposed equipment up to 48 inches in diameter or with flat surfaces to 72 inches.	PVC	20 or 30 mils		
	Aluminum	0.016, 0.020, 0.024 or 0.032 inch	Smooth, corrugated, embossed	
	Stainless Steel (304 or 316 type)	0.010, 0.016, 0.020, 0.024 inch	Smooth, corrugated, embossed	
Exposed equipment larger than 48 inches in diameter or with flat surfaces greater than 72 inches.	Aluminum	0.032 inch	Smooth	1-1/4 inch deep to
		0.040 inch	Embossed	2-1/2 inch deep 4 x 1 inch
	Stainless Steel (304 or 316 type)	0.020 inch	Smooth	1-1/4 inch deep to
		0.024 inch	Embossed	2-1/2 inch deep 4 x 1 inch
Notes:				
Install jacket over insulation material. For insulation with factory applied jacket, install the field applied jacket over the factory applied jacket.				
If more than one material is listed, selection from materials listed is Contractor's option.				

C. TABLE 3: OUTDOOR FIELD APPLIED EQUIPMENT INSULATION JACKETS

TABLE 3: OUTDOOR EQUIPMENT FIELD APPLIED INSULATION JACKET				
SERVICE	JACKET TYPE	THICKNESS OPTIONS	FINISH OPTIONS	CORRUGATION OPTIONS
Concealed equipment	PVC	20 or 30 mils		
	Aluminum	0.016 inch, 0.020inch, 0.024inch, 0.032 inch 0.040 inch	Smooth, Corrugated, Embossed	
	Stainless Steel	0.010 inch 0.016 inch 0.020 inch 0.024 inch	Smooth, Corrugated, Embossed	
Exposed equipment up to 48 inches in diameter or with flat surfaces to 72 inches.	Aluminum	0.016, 0.020, 0.024 or 0.032 inch	Smooth, Corrugated, Embossed	
	Stainless Steel (304 or 316 type)	0.010 inch 0.016 inch 0.020 inch 0.024 inch	Smooth, Corrugated, Embossed	
Exposed equipment larger than 48 inches in diameter or with flat surfaces greater than 72 inches.	Aluminum	0.032 inch 0.040 inch	Smooth Embossed	1-1/4 inch deep to 2-1/2 inch deep x 4 x 1 inch
	Stainless Steel (304 or 316 type)	0.020 inch 0.024 inch	Smooth Embossed	1-1/4 inch deep to 2-1/2 inch deep x 4 x 1 inch

TABLE 3: OUTDOOR EQUIPMENT FIELD APPLIED INSULATION JACKET				
SERVICE	JACKET TYPE	THICKNESS OPTIONS	FINISH OPTIONS	CORRUGATION OPTIONS
Notes: Install jacket over insulation material. For insulation with insulation with factory applied jacket, install the field applied jacket over the factory applied jacket. If more than one material is listed, selection from materials listed is Contractor's option.				

END OF SECTION

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SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL (LEVEL 1)

1.01 APPLICABLE REQUIREMENTS

- A. A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
1. Piping Insulation:
 - a. Piping Insulation.
 - b. Insulation Jackets.
 - c. Removable Covers.
 2. Acoustic piping wrap
 3. Section includes the following HVAC piping systems:
 - a. Heating hot water supply and return piping.
 - b. Chilled water supply and return piping.
 - c. Condenser water supply and return piping.
 - d. Steam and condensate return piping.
 - e. Heat recovery piping.
 - f. Process piping.
 - g. Valves, pumps, air separators, strainers and fittings in insulated piping systems.
 - h. Refrigerant hot gas and suction piping.
- B. Types of mechanical insulation specified in this Section include the following:
1. Glass fiber.
 2. Mineral wool.
 3. Closed cell phenolic.
 4. Polyisocyanurate.
 5. Calcium silicate.
 6. Cellular glass.
 7. Flexible elastomeric closed cell foam.

8. Aerocel.
9. Insulation jackets.
10. Removable covers.
11. Insulation accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 22: Plumbing.
- B. Section 23 05 00: Basic HVAC Materials and Methods.
- C. Section 23 21 13: Hydronic Piping, Valves and Specialties.

1.04 DEFINITIONS

- A. Ambient: The air temperature to be maintained in a conditioned room. Typically, between 70°F and 78°F.
- B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
- C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
- D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
- E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
- F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
- G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
- H. Freezing Climate: Where outdoor design temperature is less than 34°F (1°C), as stated in ASHRAE Fundamentals under 99% column for winter design conditions.
- I. Unconditioned Space: any space not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.05 INSULATION INDUSTRY DEFINITIONS

- A. Third Party Independent Product sustainable certification: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
 1. UL GREENGUARD
 2. Scientific Certification Systems (SCS)
- B. EPA: Environmental Protection Agency.

- C. WHO: World Health Organization.
- D. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.
- E. ASJ: All Service Jacket (no outer film).
- F. SSL+: Self-Sealing Lap with Advanced Closure System.
- G. SSL: Self-Sealing Lap.
- H. FSK: Foil Scrim Kraft; jacketing.
- I. FSP: Foil Scrim Polyethylene jacketing
- J. PSK: Poly Scrim Kraft; jacketing.
- K. FHC: Fire Hazard Classification
- L. PVC: Polyvinyl Chloride.
- M. Bio based Binder Technology: binder systems based on rapidly renewable bio-based materials; rather than petroleum-based chemicals commonly used in other glass mineral wool insulation materials. Biobased Technology reduces the binder embodied energy by up to 70 percent and does not contain phenol, formaldehyde, acrylics or artificial colors.
- N. UL GREENGUARD Gold Certification: Certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by the Leadership in Energy Environmental Design (LEED) Building Rating Systems.
- O. Recycled Content – Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product rather than being placed in a landfill or incinerated.
- P. Recycled Content – Pre-Consumer (aka Post-Industrial): materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.
- Q. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE and Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.
- R. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to applicable UL requirements standards for safety and standards of other National and International organizations
- S. Imperative 11, Red List – requires that manufacturers disclose the ingredients in their products to document they are free of Red List chemicals and materials. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.
- T. Underwriter’s Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification.

- U. UL Environment Claims Validation (ECV): service and label tests a manufacturer's product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service enables products to qualify for LEED® MR Credit 4 Recycled Content LEED V-4 Building product disclosure and optimization – sourcing of raw materials.

1.06 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
 - 1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
 - a. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165: Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
 - c. C168: Provides standard terminology for thermal insulation.
 - d. C177: Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - e. C195: Specification for Mineral Fiber Thermal Insulating Cement.
 - f. C196: Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
 - g. C302: Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
 - h. C303: Test Method for Density of Preformed Block-Type Thermal Insulation.
 - i. C305: Test for Thermal Conductivity of Pipe Insulation.
 - j. C335: Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
 - k. C356: Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
 - l. C411: Test for Hot-Surface Performance of High Temperature Thermal Insulation.
 - m. C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - n. C449: Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - o. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - p. C533: Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - q. C534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - r. C547: Specification for Mineral Fiber Pipe Insulation.
 - s. C552: Specification for Cellular Glass Block and Pipe Thermal Insulation.
 - t. C553: Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
 - u. C592: Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
 - v. C612: Specification for Mineral Fiber Block and Board Thermal Insulation.

- w. C755: Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation.
 - x. C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - y. C916: Standard Specification for Adhesives for Duct Thermal Insulation.
 - z. C921: Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
 - aa. C1071: Standard Specification for Thermal and Acoustical Insulation.
 - bb. C1104: Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - cc. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - dd. C1338: Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - ee. C1393: Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
 - ff. C1617-05: Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals
 - gg. E84: Test Method for Surface Burning Characteristics of Building Materials.
 - hh. E119: Test for Fire Resistance.
 - ii. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - jj. G22: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
- 2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
 - a. 90: Energy Conservation in New Building Design.
 - 3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
 - a. 255: Test Methods, Surface Burning Characteristics of Building Materials.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
 - C. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

- D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method where installed in a return air plenum or in a ventilation intake or mechanical room. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- E. Corrosiveness: Passes ASTM C1617-05, Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals.
- F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.
- G. Sustainable Project Requirements:
 - 1. Formaldehyde Free: Third party certified with UL Environment or Scientific Certification Systems (SCS) Validation.
 - 2. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).
 - 3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of GREENGUARD Certification.

1.07 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
 - 1. Pentabrominated diphenyl ether (CAS#32534-81-9).
 - 2. Octabrominated diphenyl ether (CAS#32536-52-0).
 - 3. Decabrominated diphenyl ether (CAS#1163-19-50).
- C. TT. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.08 LEED ACTION SUBMITTALS:

- A. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

- B. Product Data for Credit MR 5 Regional Materials: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
 - C. LEED v 4, Product Data for Credit EA 2: For products and materials significant to the energy performance of a structure, provide documentation that indicates that insulation levels are significant to increasing the level of energy performance beyond the prerequisite standard.
 - D. LEED v 4, Product Data for Credit MR 2: For products and materials to comply with Building Product Disclosure & Optimization, provide data/evidence that substantiates Environmental Product Declaration and Multi Attribute Optimization requirements.
 - E. LEED v 4: Product Data for Credit MR 3: For products and materials to comply with requirements for regional materials, provide documentation indicating location of product or material, manufacturing location and the point of extraction, harvest or recovery for each raw material. Include distance to Project, contractor cost for each regional material, and percent by weight that is considered regional.
 - F. LEED v 4, Product Data for Credit MR 4: For products having recycled content documentation; indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
 - G. LEED v 4, Product Data for Credit EQ 2: For products and materials to comply with low emittance standards, provide documentation substantiating that insulation products comply with requisite low emittance standards.
 - H. LEED v 4, Product Data for Credit EQ 5: For products and materials to meet the standard for both thermal comfort design and thermal comfort control, provide data to support that insulation products are significant to thermal comfort design and thermal comfort control.
 - I. LEED v 4, Product Data for Credit EQ 9: For products and materials that contribute to the design and performance of workspaces that promote occupant's well-being, productivity, and communication, provide data/documentation supporting acoustical benefits of Glass Mineral Wool insulation products.
 - J. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 1.09 DELIVERY, STORAGE, AND HANDLING
- A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
 - B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.
- 1.10 WARRANTY
- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Comply with requirements in "Part 3, Table 1: Piping Services, Fluid Temperature, and Insulation Type Required" for application of insulating materials. Products shall not contain asbestos, lead, mercury or mercury compounds if possible. Products shall meet UL GREENGUARD certification standards for low-emitting products.
- B. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. Each insulation material has been provided a descriptive key code, such as PI-A, to simplify the organization and application of materials in following sub-sections.
- E. Thickness of insulation is based on meeting or exceeding the minimum requirement of applicable energy code and/or maximum allowable external temperature in relation to adjacent combustible material or other equipment. Exterior surface temperature shall not exceed 140°F at maximum operating capacity except as noted below for generator applications.
- F. Acceptable manufacturers include Knauf Insulation, Johns Manville, Owens-Corning, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Aeroflex, Armacell, Reflectix, Pacor or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each product classification.

2.02 PIPE INSULATIONS (IDENTIFIED BY KEY CODE PI BELOW AND IN TABLE 1)

- A. PI-A, Preformed Mineral Wool or Fiberglass:
 - 1. Materials: Mineral wool or fiberglass bonded with a thermosetting resin. Product to be validated GREENGUARD Gold for low VOC's. In addition, pipe insulation to have a validated EPD from UL Environment or Scientific Certification Systems.
 - 2. Applications: Insulation of piping and fittings with thickness as required by local energy code.
 - 3. Compliant with ASTM C335, C356, C411, C447, C547, C585, C795, C1045, C1104 E96, and E84.
 - 4. Compliant with ASTM C547 Type I, 850°F (454°C) or Type IV, 1000°F (538°C).
 - 5. Thermal conductivity (K-value): 0.24 Btu•in./(hr•ft²•°F) or less, at 100°F (38°C).
 - 6. Service Temperature Range: 0°F to 850°F (-18°C to 454°C).
 - 7. Water Vapor Absorption, % of volume: <5% (maximum) as tested per ASTM C1104.
 - 8. Vapor Retarder Jacket: Factory applied ASJ or ASJ+ with SSL, white kraft paper interleaving reinforced with glass fiber scrim yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips.
 - 9. Nominal density is 2.5 lbs./cu. ft., greater.

10. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 11. Manufacturers: Knauf #ECOSE Earthwool 1000°, Johns Manville #Micro-Lok or #Micro-Lok, Owens Corning, CertainTeed, Manson or equal.
- B. PI-B, Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene:
1. Applications: Insulation of piping and fittings with thickness as required by local energy code.
 2. Compliant with UL 181, ASTM C411, C518, C534, G21/C1338, G22, D1056 and E84.
 3. Service Temperature Range: -297°F to 220°F (-183°C to 105°C).
 4. Thermal conductivity (K-value): $0.28 \text{ Btu}\cdot\text{in.}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$ or less, at 75°F (24°C).
 5. Water Vapor Absorption, % of volume: $<0.2\%$ (maximum) compliant with ASTM C209.
 6. Nominal density is 2.5 lbs./cu. ft. or greater.
 7. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 8. Seal all seams and joints with contact adhesive or factory self-seal system with lap seal tape.
 9. Manufacturers: Armacell #AP Armaflex, Rubatex #K-Flex ECO, Aeroflex #Aerocel or equal.
- C. PI-C, Rigid Closed-Cell Phenolic Foam:
1. Applications: Insulation of piping and fittings with thickness as required by local energy code.
 2. Compliant with ASTM C209, C518, C795, C1126, D1621, D1622, D2856, D6226 and E84.
 3. Service Temperature Range: -290°F to 250°F (-178°C to 121°C).
 4. Thermal conductivity (K-value): $0.18 \text{ Btu}\cdot\text{in.}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$ or less, at 75°F (24°C).
 5. Vapor Retarder Jacket – straight sections: Factory applied ASJ with SSL.
 6. Water Vapor Absorption, % of volume: $<0.87\%$ (maximum) as tested per ASTM C209.
 7. Nominal density is 2.5 lbs./cu. ft. or greater.
 8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 50 ratings as tested per ASTM E84.
 9. Manufacturers: ITW Trymer #Supercel, Kingspan #Koolphen K, Resolco #Insul-phen or equal.
- D. PI-D, Rigid Closed-Cell Polyisocyanurate Foam:
1. Applications: Rigid preformed insulation of piping, fittings, vessels, and equipment with thickness as required by local energy code. Not for use in return air plenums or ventilation ductworks.
 2. Compliant with ASTM C272, C591, C755, C1136, C920, D6226, E96, and E84.
 3. Service Temperature Range: -297°F to 300°F (-183°C to 149°C).
 4. Thermal conductivity (K-value): $0.19 \text{ Btu}\cdot\text{in.}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$ or less, at 75°F (24°C).
 5. Water Absorption, % of volume: 0.7 (maximum) as tested per ASTM C272.

6. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.
 7. Nominal density is 2 lbs./cu. ft. or greater.
 8. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 450 ratings as tested per ASTM E84. Not compliant for use in return air plenums.
 9. Manufacturers: Trymer #2000 XP, Dyplast #ISO, HiTherm or equal.
- E. PI-E, Rigid Preformed Hydrous Calcium Silicate:
1. Applications: High temperature insulation for piping and equipment and for placement at piping hangers and supports.
 2. Compliant with ASTM C165, C302, C356, C447, C533, C665, C1338 and E84.
 3. Maximum Service Temperature: 1200°F (650°C).
 4. Thermal conductivity (K-value): 0.389 Btu•in./(hr•ft²•°F) or less, at 200°F (93°C).
 5. Nominal density is 14 lbs./cu. ft. or greater.
 6. Compressive Strength (block): Minimum of 100 psi to produce 5% compression as tested per ASTM C165.
 7. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =0 ratings as tested per ASTM E84.
 8. Tie Wire: 16-gauge stainless steel with twisted ends on maximum 12" centers.
 9. Product must contain corrosion inhibiting chemistry.
 10. Manufacturers: Johns Manville Industrial Insulation Group #Thermo-12 Gold or equal.
- F. PI-F, Rigid Closed-Cell Cellular Glass:
1. Applications: Rigid closed cell glass impermeable to water and water vapor for insulating buried piping, as well as traditional application on other piping and equipment.
 2. Compliant with ASTM C165, C240, C303, C450, C552, C585, E136, E1461, and E84.
 3. Service Temperature Range: -450°F to 900°F (-268°C to 482°C).
 4. Thermal conductivity (K-value): 0.29 Btu•in./(hr•ft²•°F) or less, at 75°F (24°C).
 5. Water Vapor Absorption, % of volume: <0.2% (maximum) compliant with ASTM C240.
 6. Nominal density is 8 lbs./cu. ft. or greater.
 7. Compressive Strength (block): Minimum of 90 psi to produce 5% compression as tested per ASTM C165.
 8. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =0 ratings as tested per ASTM E84.
 9. Manufacturer: Pittsburgh-Corning #Foamglas One or equal.
- G. PI-G, Flexible Low Temperature Aerogel (Cold Fluid Piping and Equipment):
1. Applications: High performance flexible insulation for specialty insulation of low temperature piping and equipment with reduced available space or where higher thermal performance is required.
 2. Compliant with ASTM C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763 and E84.
 3. Service Temperature Range: -200°F to 200°F (-129°C to 93°C).

4. Thermal conductivity (K-value): 0.12 Btu•in./(hr•ft²•°F), or less, at 75°F (24°C).
 5. Water Vapor Absorption, % of volume: ≤5% (maximum) as tested per ASTM C1104compliant with ASTM C240.
 6. Nominal density is 10 lbs./cu. ft. or greater.
 7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
 8. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
 9. Manufacturer: Pacor #Cryogel X201 or equal.
- H. PI-H, Flexible High Temperature Aerogel (Hot Fluid Piping and Equipment):
1. Applications: High performance flexible insulation for specialty insulation of high temperature piping and equipment with reduced available space or where higher thermal performance is required.
 2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
 3. Service Temperature Range: 32°F to 482°F (0°C to 250°C).
 4. Thermal conductivity (K-value): 0.12 Btu•in./(hr•ft²•°F), or less, at 212°F (100°C).
 5. Water Vapor Absorption, % of volume: ≤5% (maximum) as tested per ASTM C1104compliant with ASTM C240.
 6. Nominal density is 10 lbs./cu. ft. or greater.
 7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
 8. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
 9. Manufacturer: Pacor #Pryogel 2250.
- I. PI-I, Flexible Extreme High Temperature Aerogel (High Temperature Exhaust Piping and Equipment):
1. Applications: High performance flexible insulation for specialty insulation of extreme high temperature piping and equipment with reduced available space or where higher thermal performance is required.
 2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
 3. Service Temperature Range: 32°F to 1200°F (0°C to 650°C).
 4. Thermal conductivity (K-value): 0.16 Btu•in./(hr•ft²•°F), or less, at 212°F (100°C).
 5. Water Vapor Absorption, % of volume: ≤5% (maximum) as tested per ASTM C1104compliant with ASTM C240.
 6. Nominal density is 12.5 lbs./cu. ft. or greater.
 7. Compressive Strength: ≥ 5 psi to produce 10% compression as tested per ASTM C165.
 8. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
 9. Manufacturer: Pacor #Pryogel XTE.

2.03 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ+: White, polypropylene-coated, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 3. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 4. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 5. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.04 JACKETING MATERIALS

- A. Field Applied Jackets (For Indoor Applications):
1. All longitudinal seams shall be located on bottom of pipes.
 2. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
 3. PVC Plastic:
 - a. High-impact-resistant, UV-resistant PVC as tested per ASTM C553, C547, C665, C795, C1338, D1784, E96, C1136 and D3679.
 - b. One piece molded type fitting covers and jacketing material.
 - c. Adhesive: As recommended by jacket material manufacturer.
 - d. Color: White.
 - e. Thickness: 20 mil (0.5 mm), minimum.
 - f. Service Temperature Range: 0°F to 150°F (-18°C to 66°C).
 - g. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
 - h. Manufacturers: Johns Manville #Zeston 2000, Proto #LoSmoke or equal by PIC Plastics, Proto Corporation, Speedline Corporation or equal.
 4. Aluminum Jacket:
 - a. Comply with ASTM B209/B209M.
 - b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
 - c. Thickness: 0.016" thick sheet (minimum).
 - d. Finish: Smooth or stucco embossed
 - e. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - f. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - g. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.

- h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
- 5. Canvas Jacket:
 - a. Cotton or fiberglass cloth.
 - b. UL listed fabric treated with dilute fire retardant.
 - c. Lagging adhesive per manufacturer.
 - d. Manufacturers: GJC General, GLT Products, Foster #Mast-A-Fab, Childers #Chil-Glas No. 5 or equal.
- B. Field Applied Jackets (For Outdoor Applications): All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
- 1. Secure stainless steel or aluminum jackets with 3/8" or 1/2" stainless steel bands on 12" centers and at each joint.
 - 2. PVC Jacket: Not allowed for outdoor applications.
 - 3. Canvas Jacket: Not allowed for outdoor applications.
 - 4. Aluminum Jacket:
 - a. Comply with ASTM B209/B209M.
 - b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
 - c. Thickness: 0.016" thick sheet (minimum).
 - d. Finish: Smooth, stucco embossed or corrugated surface.
 - e. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
 - f. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - g. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
 - 5. Self-Adhesive Aluminum Jacket:
 - a. Comply with ASTM D774, C1338, C1371, E96 and D882.
 - b. Thickness: 56 mils (minimum).
 - c. Multi-ply UV-resistant aluminum foil/polymer laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
 - d. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
 - e. Weight: 0.3 lbs./sf, minimum.
 - f. Service Temperature Range: -15°F to 160°F (-26°C to 71°C).
 - g. Manufacturer: Polyguard Products #Alumaguard or equal.
 - 6. Stainless Steel Jacket:
 - a. Comply with ASTM A240 and A666.
 - b. Stainless steel alloy T-304 or T-316. T-316 shall be used in corrosive environments including close proximity to coast.

- c. Thickness: 0.016" thick sheet (minimum).
 - d. Dull Finish: Smooth, stucco embossed or corrugated surface.
 - e. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
 - f. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
 - g. Longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8" or 1/2" stainless steel bands on 12" centers.
 - h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
- C. S. Removable Covers:
- 1. Provide removable covers on indoor pumps, valves, air separators, air vent fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation is required.
 - a. Pre-molded insulation covers:
 - 1) Cold Systems: Provide PVC covers over insulated elbows, fittings and flanges.
 - 2) Cold Systems: Provide flexible closed cell foam or removable cloth insulating blankets for valves, pumps and strainers.
 - 3) Hot Systems: Provide PVC covers over insulated elbows, fittings and flanges.
 - 4) Hot Systems: Provide removable cloth insulating blankets on valves, pumps, and strainers.
 - b. Removable cloth insulating blankets:
 - 1) Service Operating Temperature: 0-350°F.
 - 2) Jacket and Liner: silicon or teflon impregnated mineral wool cloth.
 - 3) Liner Reinforcement: stainless steel mesh cloth.
 - 4) Insulation: Fiberglass matt or Pacor #Aerogel, 2" thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
 - 5) Fastening: 2" Nomex Velcro or 1" straps and stainless steel D-rings or 12-gage stainless steel hooks and stainless steel wire.
 - 6) Thread: Kevlar/stainless steel thread.
 - 7) Outdoor Applications: Jacket shall be UV and ozone resistant with Velcro attachment.
 - 8) Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, Alpha or equal.

2.05 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive:
 - 1. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 1200°F (10 to 649°C).

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Childers Brand #CP-97, Johns Manville #CalBond Gold, Marathon Industries #290, Foster Brand #81-27, Mon-Eco Industries #22-30, Vimasco Corporation #760 or equal.
- C. Cellular-Glass Adhesive:
1. Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200°F (minus 73 to plus 93°C).
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Foster Brand #81-84 or equal.
- D. Phenolic and Polyisocyanurate Adhesive:
1. Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300°F (minus 59 to plus 149°C).
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Childers Brand #CP-96, Foster Brand #81-33 or equal.
- E. Flexible Elastomeric and Polyolefin Adhesive:
1. Comply with MIL-A-24179A, Type II, Class I.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Manufacturers: Armaflex #520 Adhesive, Foster Brand #85-75, K-Flex USA #R-373, Aeroflex USA, Aeroseal, Armacell, or equal.
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Childers Brand #CP-127, Eagle Bridges - Marathon Industries #225, Foster Brand #85-60/85-70, Mon-Eco Industries, Inc.#22-25 or equal.
- G. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Childers Brand #CP-82, Eagle Bridges - Marathon Industries #225, Foster Brand #85-50, Mon-Eco Industries, Inc.#22-25 or equal.
- H. PVC Jacket Adhesive: Compatible with PVC jacket.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Dow Corning Corporation #739, Dow Silicone, Johns Manville #Zeston Perma-Weld, CEEL-TITE #Solvent Welding Adhesive, P.I.C. Plastics, Inc. #Welding Adhesive, Speedline Corporation #Polyco VP Adhesive or equal.

2.06 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based for indoor use.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
 3. Vapor Safe Coating: Shall meet requirements of LEED IEQ Low-Emitting Materials. VOC 33 g/l, less water and exempt solvents.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.
 6. Manufacturers: Foster Brand #30-80/30-90, Vimasco Corporation #749 or equal.
- C. Vapor-Barrier Mastic: Solvent based for outdoor use.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
 2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104°C).
 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 4. Color: White.
 5. Manufacturers: Childers Brand #Encacel X CP-40, Eagle Bridges - Marathon Industries #570, Foster Brand #60-95/60-96 or equal.
- D. Breather Mastic: Water based for indoor and outdoor use.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
 3. Solids Content: 60 percent by volume and 66 percent by weight.
 4. Color: White.
 5. Manufacturers: Childers Brand #CP-10/CP-11, Eagle Bridges - Marathon Industries #550, Foster Brand #46-50, Mon-Eco Industries, Inc. #55-50, Vimasco Corporation #WC-1/WC-5 or equal.

2.07 LAGGING ADHESIVES

- A. Adhesives shall be compatible with insulation materials, jackets, and substrates.
1. Comply with MIL-A-3316C, Class I, Grade.
 2. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 4. Service Temperature Range: 0 to 180°F (-18 to 82°C).

5. Color: White.
6. Manufacturers: Childers Brand #CP-50 AHV2, Foster Brand #30-36, Vimasco Corporation #713/714 or equal.

2.08 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate.
 - a. Manufacturers: Childers Brand #CP-76, Marathon Industries#405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05, Pittsburgh Corning Corporation #Pittseal 444 or equal.
2. Joint Sealants for Polystyrene.
 - a. Manufacturers: Childers Brand #CP-70, Marathon Industries #405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05 or equal.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: -100 to 300°F (-73 to 149°C).
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Shall be compliant with requirements of LEED IEQ Low-Emitting Materials.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturers: Childers Brand #CP-76, Eagle Bridges - Marathon Industries #405, Foster Brand #95-44, Mon-Eco Industries, Inc. #44-05 or equal.

C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturers: Childers Brand #CP-76 or equal.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 11.5 mils (0.29 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
 7. Manufacturers: ABI, Ideal Tape Division #428 AWF ASJ, Avery Dennison Corporation #Fasson 0836, Compac Corporation #105, 3M Venture Tape #1540 CW Plus/1542 CW Plus/1542 CW Plus/SQ or equal.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 6.5 mils (0.16 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
 7. Manufacturers: ABI Tape #491 AWF FSK, Avery Dennison Corporation #Fasson 0827, Compac Corporation #110 and 111, 3M Venture Tape #1525 CW NT/1528 CW/1528 CW/SQ or equal.
- C. LL. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
 2. Thickness: 6 mils (0.15 mm).
 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
 6. Manufacturers: ABI Tape #370 White PVC tape, Compac Corporation #130, Venture Tape #1506 CW NS or equal.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
 6. Manufacturers: ABI Tape #488 AWF, Avery Dennison Corporation #Fasson 0800, Compac Corporation #120, 3M Venture Tape #3520 CW or equal.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304, 0.020 inch (0.50 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application. Manufacturers: ITW Insulation Systems, Gerrard Strapping and Seals, RPR Products, Inc., Insul-Mate Strapping, Seals, and Springs or equal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers: AGM Industries #CWP-1, GEMCO #CD, Midwest Fasteners #CD, Nelson Stud Welding #TPA/TPC/TPS or equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
 - a. Manufacturers: AGM Industries #CHP-1, GEMCO #Cupped Head Weld Pin, Midwest Fasteners #Cupped Head, Nelson Stud Welding #CHP or equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel coordinated with application, fully annealed, 12 gauge, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - d. Manufacturers: AGM Industries, Inc. #Tactoo Perforated Base Insul-Hangers, GEMCO #Perforated Base, Midwest Fasteners, Inc. #Spindle or equal.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

- c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - d. Manufacturers: GEMCO #Nylon Hangers, Midwest Fasteners, Inc.#Nylon Insulation Hangers or equal.
- 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, as coordinated with application. 12 gauge, 0.106-inch - (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 - d. Manufacturers: AGM Industries, Inc. #Tactoo Self-Adhering Insul-Hangers, GEMCO #Peel & Press, Midwest Fasteners #Self Stick or equal.
- 6. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch- (0.41-mm-) thick, galvanized-steel, aluminum or stainless-steel sheet, as coordinated with application with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - b. Manufacturers: AGM Industries #RC-150, GEMCO #R-150, Midwest Fasteners #WA-150, Nelson Stud Welding #Speed Clips or equal.
- 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - a. Manufacturers: GEMCO, Midwest Fasteners, Inc or equal.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
 - 1. Manufacturers: C & F Wire or equal.

2.11 ACOUSTICAL PIPE WRAP

- A. Acoustical pipe lagging for noisy pipes. Barrier material shall meet the sound transmission loss and physical properties performance requirements as follows:
 - 1. Vinyl noise barrier with reinforced foil facing on one side.
 - 2. Service Temperature Range: -40°F to 220°F (-40°C to 104°C).
 - 3. Nominal density: 2 lbs./sf or greater.
 - 4. Surface Burning Characteristics: Flame Spread Index ≤ 25 and Smoke Developed Index ≤ 450 ratings as tested per ASTM E84. Not compliant for use in return air plenums without metal jacket.
 - 5. Sound transmission class: 31

6. Sound Transmission Loss (dB) Table per ASTM E90:

dB Reduction at each Octave Band Center Frequency (Hz)						
125 hz	250 hz	500 hz	1000 hz	2000 hz	4000 hz	STC
16	22	26	32	35	40	31

7. Manufacturers: Sound Seal #B-20 LAG/QFA-9, Kinetics #KNM-100AL Series or equal.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.
- B. Verify that all surfaces are clean, dry and free of foreign material.

3.02 INSTALLATION

- A. General:
 1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
 2. Remove and replace any insulation that has become wet or damaged during the construction process.
 3. Pipe fittings, valves, pipe flanges, pumps, strainers, gauge fittings, etc., shall be insulated to the same insulation thickness as adjoining piping and as required by local energy code.
- B. Piping Insulation:
 1. Locate insulation and cover seams in least visible locations unless otherwise specified.
 2. Neatly finish insulation at supports, protrusions, and interruptions.
 3. Provide vapor retardant jackets with self-sealing laps on insulated cold pipes conveying fluids below ambient temperature. Insulate complete system. Staples used on pipes conveying fluids below ambient temperatures (cold systems) must be covered with approved mastic.
 4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self-sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
 5. Provide insert between support shield and piping on piping 1-1/2" diameter and larger. Fabricate insert using hydrous calcium silicate or other heavy density insulating material suitable for temperature and required insulation thickness. Insulation inserts shall not be less than the following lengths:
 - a. 1-1/2" to 2-1/2" pipe size: 10" long
 - b. 3" to 6" pipe size: 12" long
 - c. 8" to 10" pipe size: 16" long
 - d. 12" and over: 22" long
 6. Use of metal saddles is acceptable as specified in Section 230500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
 7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices.

8. For insulated pipe exposed in mechanical equipment rooms or in finished spaces below seven (7) feet above finished floor, cover insulation with PVC or metal jacketing.
9. Where pumps, valves (manual and control types), strainers, etc., with insulation require periodic opening for maintenance, repair or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.
 - a. Cold Systems: Provide elastomeric foam for pumps and strainers.
 - b. Hot Systems: Provide removable blanket covers on valves, pumps, and strainers.
10. For exterior applications:
 - a. Apply weather-resistant protective finish to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping.
 - b. All lateral and longitudinal insulation joints to be sealed with low VOC, UV inhibitive adhesive.
 - c. Provide weather protection jacket over insulation. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. PVC or plastic jackets are not allowed exterior to the building. Jacket seams shall be located on bottom side of horizontal piping. All lateral jacket joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal jacket joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
11. For underground installations, install per manufacturer's written instructions and recommendations.
12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.
13. Special Application Requirements for Chilled Water Systems:
 - a. Non-factory vapor retarded piping and fittings: Spiral wrap insulation with vapor retarder tape. Cover with PVC jacket.
 - b. 90/45/tee fittings: Provide material routed out of bun stock to the shape of the elbow, cut in half and applied to the fitting and spiral wrapped with vapor retarder tape. Cover with PVC fitting cover.
 - c. Installation shall conform to insulation manufacturer's installation guide.
 - d. Longitudinal jacket laps for pipe insulation installed on piping systems with operating temperatures below ambient shall be vapor sealed with factory-applied pressure-sensitive adhesive vapor retarder, self-sealing lap. For proper sealing, firmly rub lap joints with reasonable pressure being applied with a plastic squeegee or sealing tool. Vapor seal all circumferential joints with factory-furnished, matching pressure-sensitive butt strips installed with reasonable pressure being applied with a plastic squeegee or sealing tool. Additionally, coat raw edges of pipe insulation sections with vapor retarder mastic at 12 foot to 21 foot intervals; at Engineer's discretion on straight piping, and on either side of all fittings, flanges or valves. Vapor retarder mastic shall completely coat the ends of the pipe and extend onto the bore of the pipe insulation and onto the jacketing a minimum of 2 inches.
 - e. Where pipe attachments or seismic supports are bolted or welded directly to the pipe provide insulation and vapor barrier around such metal support elements, that extend beyond the pipe insulation, as required to prevent condensation from forming on exposed metal and bolts.

14. Jacket Locations for Pipe, Valve and Fittings. Provide protective insulation jackets for the following locations where not defined elsewhere in the specifications for piping systems:

15.

Insulation Jacket Location	Jacket Material
Indoors: Concealed in Accessible Ceiling Voids.	None.
Indoors: Concealed in Inaccessible Ceiling Voids.	None.
Indoors: Concealed in Accessible Portions of Shafts or Chaseways.	None.
Indoors: Concealed in Inaccessible Portions of Shafts or Chaseways.	None.
Indoors: Mechanical Rooms.	PVC or Aluminum or Stainless Steel to seven (7) feet AFF.
Indoors: Exposed to view in normally occupied spaces such offices, conference rooms, restaurants and retail spaces.	PVC.
Indoors: Exposed to view in warehouse, storage and manufacturing spaces.	None.
Outdoors: Exposed to weather.	Aluminum or stainless steel with white coating for low emissivity.
Outdoors: Exposed in covered outdoor areas such as garages or under canopies.	Aluminum or stainless steel.
Outdoors: Located in vaults or accessible concrete trenches.	Aluminum or stainless steel.

3.03 PIPING INSULATION SCHEDULE

A. TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED.

1. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness by 1/2" (minimum) where insulated pipe is exposed to exterior ambient air. Minimum thermal resistance shall comply with building code minimum ranges and may exceed those minimum levels. Insulation thicknesses may be adjusted for equivalent insulation values for materials with superior "K" factors. Refer to "PART 2-PRODUCTS" for characteristics of each insulation material listed below.

PIPE INSULATION INDEX	
INSULATION KEY CODE	INSULATION TYPE
PI-A	Preformed Flexible Mineral Wool or Fiberglass.
PI-B	Preformed Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene.
PI-C	Preformed Rigid Closed-Cell Phenolic Foam.
PI-D	Preformed Rigid Closed-Cell Polyisocyanurate Foam. Limited to non-plenum rated applications.
PI-E	Rigid Preformed Hydrous Calcium Silicate.
PI-F	Rigid Closed-Cell Cellular Glass.
PI-G	Flexible Low Temperature Aerogel.
PI-H	Flexible High Temperature Aerogel.
PI-I	Flexible Extreme High Temperature Aerogel.

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes at pipe hangers and supports with saddles or 360° shields.	PI-E	Thickness as required by State Energy Code. See Table 2 below. Refer to 230500 Basic HVAC Materials and Methods for length of saddles and shields based on pipe size. Required on pipe sizes 1-1/2" and larger.
Chilled water supply and return systems and fittings (40°F to 60°F).	PI-A, B, C, D, G	Thickness as required by State Energy Code. See Table 2 below.
Chilled water supply and return systems and fittings (39°F and below).	PI-A, B, C, D, G	Thickness as required by State Energy Code. See Table 2 below.
Heating water supply and return systems and fittings (up to 200°F).	PI-A, B, C, E, H	Thickness as required by State Energy Code. See Table 2 below.
Cooling coil condensate drain piping and traps located inside spaces within the building, and above ceilings and in attics.	PI-A or B	Provide 1/2" (minimum) thickness insulation, all pipe sizes. Refer to Division 22.
Cooling coil condensate drain piping and traps located inside the building, in mechanical rooms located in buildings located in humid climates defined as "A-Moist" or "C-Marine" in the IECC.	PI-A or B	Provide 1/2" (minimum) thickness insulation, all pipe sizes. Refer to Division 22.

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Cooling coil condensate drain piping and traps located outdoors.	N/A	Not required.
Refrigerant suction piping.	PI-B	Provide 3/4" (minimum) thickness insulation or increased thickness as required by State Energy Code. See Table 2 below.
Refrigerant liquid and hot-gas piping.	PI-B	Provide 3/4" (minimum) insulation for all warm/hot piping in close proximity to human contact and where located in enclosed ceiling, shaft or chase spaces.
Refrigerant piping for heat pump and VRF systems.	PI-B	Provide 3/4" (minimum) thickness insulation on all piping.
Low pressure steam supply and condensate systems (250°F and below).	PI-A, C, D, F, H	Thickness as required by State Energy Code. See Table 2 below.
Medium and high pressure steam supply and condensate systems (Greater than 250°F).	PI-A, E, F, H, I	Thickness as required by State Energy Code. See Table 2 below.
Steam condensate pump discharge systems (141°F-200°F).	PI-A, D, F, H	Thickness as required by State Energy Code. See Table 2 below.
Boiler feed systems (201°F-250°F).	PI-A, D, F, H	Thickness as required by State Energy Code. See Table 2 below.
Boiler blow down systems.	PI-A, D, F, H	Provide 1" insulation thickness, all piping sizes.
Steam safety valve vent piping systems.	PI-A, D, F, H	Provide 1" insulation thickness, all piping sizes. Provide aluminum jacket on exterior insulated piping.

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Interior and exterior geothermal condenser water supply and return systems and fittings (59°F and below).	PI-A, B, C, D, E	Above grade piping only. Below grade not insulated.
Generator engine exhaust piping, including flanges, fittings, mufflers, filters, etc.	PI-E	4" (100 mm). Thickness is based on desired exterior surface temperature defined by code and not to exceed 158°F per UL2200 for casual contact.
	PI-I	2" (50 mm). Thickness is based on desired exterior surface temperature defined by code and not to exceed 158°F per UL2200 for casual contact.
Electric heat traced systems.	Per fluid type	Provide aluminum jacket on exterior insulated piping.

B. TABLE 2: MINIMUM PIPING INSULATION THICKNESS BASED ON FLUID TEMPERATURE AND PIPING SIZE. California

Table 2							
Insulation Based on California T-24 Energy Code Table 120.3-A							
Minimum Pipe Insulation Thicknesses or Greater							
FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)				
			Less than 1	1 and 1-1/4	1-1/2 to 3	4 to 6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)				
Space heating systems (steam, steam condensate and hot water) and Domestic Services Water Heating Systems							
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.31	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.22-0.28	100	1.0	1.5	1.5	1.5	1.5
Space cooling systems (chilled water, refrigerant and brine)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
40-60 residential	0.21-0.27	75	0.75 for residential		1.0	1.0	1.0
Below 40	0.20-0.27	75	1.0	1.5	1.5	1.5	1.5

3.04 ACOUSTIC PIPE WRAP

A. Acoustic pipe wrap is to be used in piping system which occur over occupied spaces for the following:

1. Horizontal condenser water riser offsets.
2. Pipe, valves and fittings where water velocity exceeds 8 feet per second.

END OF SECTION

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SECTION 23 09 00

BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:
1. Provide new direct digital Building Automation System (BAS) for the new building with all hardware, software, controller, devices, sensors, conduit, wiring, and labor as required to provide complete and operational systems.
 2. Provide Tridium front end to interface existing building BAS systems with new building BAS.
- B. General Requirements
1. The work includes designing, providing and installing a complete and fully operable building automation system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the authorities having jurisdiction. The system shall be non-proprietary. Any alternations to the quantity or location of the control panels shall be coordinated with the Electrical Contractor and General Contractor prior to bidding. Any BAS changes after bidding must be coordinated with Electrical Contractor and General Contractor at no additional cost to Owner.
 2. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
 3. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
 4. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
 5. Controls dampers are specified and furnished in Section 233113 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
 6. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner's acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.

7. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owner's Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
8. Owner training on operation of the control system.
9. One-year warranty on workmanship and materials.
10. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Refer to Division 0 and Division 1 for related contractual requirements.
- B. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.
- C. Refer to Division 23 and the following sections for Mechanical or Electrical Provision.
 1. Division 01 - Submittal Procedures
 2. Division 01 - Commissioning
 3. Section 23 05 00 - Basic HVAC Materials and Methods
 4. Section 23 05 93 - Testing, Adjusting, and Balancing
 5. Section 23 09 02 - Variable Frequency Drives
 6. Section 23 21 13 - Hydronic Piping, Valves and Specialties
 7. Section 23 21 23 - Hydronic Pumps
 8. Section 23 31 13 - Air Distribution
 9. Sections 23 70 00 through 23 89 99 equipment
 10. Division 26 – Electrical Materials and Methods
 11. Division 28 – Electronic Safety and Security
- D. Refer to Division 26 sections for Electrical Provisions. Sources of 120-volt electrical power as indicated on the electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.
- E. BAS contractor will furnish, but not install the following:
 1. Air flow measuring stations: furnish to mechanical installer and coordinate per manufacturer's requirements.
 2. Flow meters: furnish to mechanical installer and coordinate per manufacturer's requirements.
 3. Flow switches: furnish to mechanical installer and coordinate per manufacturer's requirements.
 4. Hydronic pressure and temperature sensor wells: furnish to mechanical installer and coordinate per manufacturer's requirements.
 5. Control valves: furnish to mechanical installer and coordinate per manufacturer's requirements.

1.04 REFERENCE STANDARDS

- A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
 2. ANSI/ASHRAE Standard 135-2012, BACnet.
 3. International Building Code (IBC), including local State and Local amendments.
 4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
 5. National Electrical Code (NEC).
 6. FCC Part 15, Subpart J, Class A.
 7. EMC Directive 89/336/EEC (European CE Mark).
 8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.
- B. City, county, state, and federal regulations and codes in effect as of contract date.
- C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.05 GENERAL REQUIREMENTS

- A. Furnish a distributed logic BACnet-based control system including operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.
- B. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
- C. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
- D. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.
- E. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.
- F. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.
- G. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

- H. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.
- I. Provide a comprehensive operator and technician training program as described herein.
- J. Provide as-built documentation, operator's terminal software, a software key for a minimum of one additional computer (coordinate with Owner's Representative if additional keys are required), diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.
- K. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.
- L. Provide each global controller (i.e. JACE 9000) with a 5-year software maintenance plan.

1.06 TRIDIUM REQUIREMENTS

- A. The Building Automation System (BAS) specified herein is an "integrated" system that utilizes a Tridium Niagara (N4) front end with BAS contractor's native BACnet controllers. The BAS contractor shall furnish and install all Tridium Niagara (N4) based front end, hardware systems, and equipment to access and interface with a BACnet control system that utilizes unitary controllers to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, etc., and all air handlers, boilers, chillers, and any other listed equipment.
- B. The BAS contractor shall develop, test, and commission all Tridium Niagara (N4) and GUI (Graphic User Interface) software applications for the HVAC control system. Additionally, the BAS contractor shall configure and commission the Ethernet communication network for the HVAC system.
- C. Only BAS contractors that are Factory Authorized to sell and install the Niagara (N4) hardware and software are authorized to bid. The Niagara (N4) Authorized Contractor will have a minimum of three factory trained programmers. The programmers will have completed the Niagara (N4) Certification Program and work as full time employees, not sub-contractors.
- D. It is the owner's express goal to implement an open system that will allow products from various suppliers to be integrated into unified systems in order to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project(s). All Niagara (N4) software licenses shall have the 'accept.station.in="*"'; accept.station.out="*", accept.wb.in="*" and 'accept.wb.out="*" section of the software licenses. The intent is to insure that the installed Niagara (N4) products may be completely open for integrations. The Owner shall be free to direct the modifications of the any software license, regardless of supplier. In addition, the Owner shall receive ownership of all job specific software configurations documentation, data files, and application-level software developed for the project. This shall include all custom job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use within Niagara (N4) Framework (Niagara (N4)) based controllers and/or servers and any related LAN/ WAN Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the Owner.

- E. Furnish a distributed logic BACnet-based control system, compatible operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.
- F. The Web Server is a flexible network server for multiple connected Niagara controllers. The Web Supervisor is designed to harness the power of the Internet and provide efficient integration and aggregation of the information from multiple controllers. In effect, the Web Supervisor creates a single view of these multiple devices, while providing a powerful network environment with comprehensive database management, alarm management, and messaging services. In addition, the Web Supervisor provides the engineering environment used to set up and manage the systems and the graphical user interface. The software is designed to run on 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better. The browser interface utilizes HTML5. JAVA is not required for the system and graphics to operate.
 - 1. Processor: Intel Xeon CPU E5-2640 x64, or better, and is compatible with dual and quad core processors.
 - 2. RAM: 4 Gb of memory minimum.
 - 3. Hard disk: minimum 4 TB hard drive and additional space for archiving purposes.

1.07 SYSTEM DESCRIPTION

- A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2012, BACnet and achieved listing under the BACnet Testing Laboratories BACnet - Advanced Workstation Software (B-AWS). This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.
- B. The Building Automation System (BAS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.
- C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.
- D. All application controllers for every piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

- E. Room sensors shall be provided with digital readout that allow the user to view room temperature, CO2 or relative humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

1.08 QUALITY ASSURANCE

- A. The BAS shall be designed, installed, commissioned, and serviced by contractor authorized and trained personnel. System provider shall have an in-place support facility within two (2) hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.
- B. The manufacturer and installer shall have a minimum of 5 years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A list of successful past projects of similar type, size and complexity shall be submitted. In addition, a reference list of names, addresses and telephone numbers of the design Engineer and the Owner's Representative for each installation shall be provided. The references may be contacted and questioned about the timely delivery, installation, operation and service received for each installation.
- C. The contractor shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.
- D. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.
- E. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.
- F. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.
- G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- H. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.
- I. Control components shall be products of the same manufacturer only, unless indicated otherwise and approved by Owner's Representative. Example – all valves shall be by one manufacturer and all temperature sensors shall be by one manufacturer.

1.09 SUBMITTALS

- A. Drawings
 - 1. The system supplier shall submit point-to-point engineered drawings, control sequence, and bill of materials for approval.
 - 2. Drawings shall be submitted in a standard size of 11" x 17" (ANSI B), or larger.

3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on portable memory device, DVD or CD disk media.

B. System Documentation

1. Include the following in submittal package:
 - a. System configuration diagrams in simplified block format.
 - b. All input/output object listings and an alarm point summary listing.
 - c. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
 - d. Complete bill of materials, valve schedule with Cv, valve pressure drop at design flow, and damper schedule.
 - e. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
 - f. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
 - g. For all system elements—operator's workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2012.
 - h. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
 - i. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.10 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.
- C. Warrant work as follows:
 1. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
 2. Warrant all actuators for a period of five (5) years.
 3. Respond during normal business hours within 24 hours of Owner's warranty service request.
 4. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

5. If Owner's Representative determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Owner's Representative will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
6. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
7. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable BAS Manufacturers include:
 1. ALC (LAVC campus only)
 2. ABB
 3. Honeywell Cipher
 4. Johnson Controls FX

2.02 OPERATOR'S WORKSTATION

- A. Where virtual servers are not utilized, the general structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients. Where a virtual server is utilized, the operator for each campus shall access the virtual server via VPN.
- B. Primary Operator Workstation Hardware
- C. All workstations shall be general purpose microcomputer systems serving as an operator station in a cooperative processing server/client relationship with other connected work stations. The workstation shall consist of a high-speed central processing unit (CPU) with data storage facilities, high-resolution, 24", LCD monitor. Components shall be capable of operating in environments of 60°F to 105°F and relative humidity of 30% to 90%.
 1. CPU: Intel Xeon CPU E5-2640 x64, or better, and compatible with dual & quad core processors.
 2. Memory: 8 GB (minimum).
 3. Hard Drive: 1 TB (minimum) for the BAS operating software.
 4. Hard Drive: 4 TB (minimum) to be used for trend log archiving of annual data.
 5. Display: Video card and monitor capable of displaying 1920x1080 pixel resolution or better.

6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector, or greater).
7. Keyboard: The keyboards shall be the enhanced with 101 keys and quiet.

D. Displays

1. In general, the operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment.
2. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
3. The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.
4. The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.

E. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
2. Each operator's terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be capable of accepting 8 characters or more, User Name shall be 0–29 characters, and Passwords must accept a minimum of 4 characters and be capable of accepting 8 characters or more.

F. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

1. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

G. Operator Activity Log

1. Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.

2. Log shall be gathered and archived to hard drive on operator's workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

H. Scheduling

1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

I. Alarm Indication and Handling.

1. Operator's workstation shall provide audible, visual, printed, email or test means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.
3. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

J. Trendlog Information

1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to view all trended records, both stored and archived. All trend log records shall be displayed in standard engineering units. Annual trend log data shall be archived by year for future analysis.
2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trend log shall support a custom scale setting for the graph view that is to be stored continuously.

3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
4. System shall be capable of using Microsoft SQL as the system database.

K. Energy Log Information

1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

L. Demand Limiting

1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a "first off-first on" mode, and in the other the loads are just shed/restored in a "first off-last on" (linear) fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

M. Tenant Activity

1. System shall include program that monitors after-hours overrides by tenants, logs that data, and generates a bill based on usage and rate charged for each tenant space. Tenant Activity program shall be able to assign multiple zones, from a list of every zone connected to system, to a particular tenant. Every zone is monitored for after-hour override usage and that data logged in server. Operator may then generate a bill based on the usage for each tenant and the rate charged for any overtime use.
2. Configuration shall include entry of the following information for use in logging and billing:

- a. Tenant's contact name and address.
 - b. One or multiple tenant zones that make up a total tenant space, including a separate billing rate for each separate zone.
 - c. Minimum and maximum values an event duration and event limit.
 - d. Property management information.
 - e. Overall billing rate.
 - f. Seasonal adjustments or surcharge to billing rate.
 - g. Billing notification type such including, but not limited to printer, file and email.
 - h. Billing form template.
 - i. Logging shall include recording the following information for each and every tenant event.
 - j. Zone description.
 - k. Time the event begins.
 - l. Total override time.
 - m. Limits shall be applied to override time.
3. A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to view and be able to delete events from billing and edit a selected tenant activity event's override time.

N. Reports

1. System server shall be capable of periodically producing reports of trend logs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

O. Configuration/Setup

1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

P. Field Engineering Tools

1. Operator's workstation software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

2. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
3. System shall automatically notify the user when a device that is not in the database is added to the network.
4. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
5. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

Q. Workstation Hardware

1. Workstation/server computer minimum requirements
 - a. Enterprise Server (supports heavy trending and/or alarm handling at very large sites using SQL Server)
 - b. 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better,
 - c. Browser/client requirements: Most current versions of the following: Internet Explorer, Firefox, Chrome, Safari (Mac OS X).

R. Software

1. At the conclusion of project, contractor shall provide to the Owner's Representative a portable memory device or DVD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the Owner to completely restore the system in the case of a computer malfunction.

2.03 WEB INTERFACE

A. General

1. BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through Owner-supplied Ethernet network connection. Web page host may be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server may be a separate computer from the Web page host device. The Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to support simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology

1. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the webpage host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications

1. Web page host shall support Ethernet network connections. A network connection shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate using BACnet, allowing the Web page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
2. An Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web page host. The Web page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive Web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
3. The Web page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.

D. Display of Data

1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered using the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment

1. Web access shall allow user to view and edit all schedules in the system. This includes three types of schedules: standard, holiday and event. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all three schedule types must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information

1. User shall use standard browser technology to view all trendlogs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the Web interface to local computer. Data shall be in CSV format.

G. Alarm Handling

1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation

1. Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access using any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log

1. Access through Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to Web page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication

1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.04 BUILDING NETWORK CONTROLLER

A. Building Network Controller

1. BACnet Conformance
 - a. Building Network Controller shall be approved by the BACnet Testing Laboratories as meeting the BACnet Building Controller requirements.

B. Building network controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.

1. Logging Capabilities
 - a. Logs shall be supported in the building network controller. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
 - b. Logs may be viewed both on-site or off-site using WAN or remote communication.
 - c. Building network controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

- d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
2. Alarm Generation
 - a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
 - b. Each alarm may be dialed out as noted elsewhere.
 - c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
 - d. Controller must be store alarms as BACnet event enrollment objects, with system destination and actions individually configurable.
 3. Demand Limiting
 - a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
 - b. Load shedding programs in building controller modules shall operate as coordinated with local utility.
 4. Tenant Activity Logging
 - a. Tenant activity logging shall be supported by building network controller module.
- C. Ethernet – MS/TP Module
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
 2. All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
 - a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
 - b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).
- D. MS/TP Module
1. MS/TP module shall support every listed function in this specification and the following.
 2. Building controller MS/TP module communications shall be through BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.
 - a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
 - b. Configuration shall be through RS-232 connection.
- E. Power Supply Module
1. Input for power shall accept between 17–30VAC, 47–65Hz.

2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

F. Modbus Module

1. Modbus Module shall support every function as listed in this specification.
2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
 - a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
 - b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
 - c. EIA-485 connection shall support connection of up to 247 Modbus units.
 - d. Configuration shall be via RS-232 connection.
3. BACnet Translation
 - a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
 - b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.05 TRIDIUM NETWORK INTEGRATION

- A. The Building Automation System (BAS) specified herein is an “integrated” system that utilizes a Tridium Niagara (N4) front end with BAS contractor’s native BACnet controllers. The BAS contractor shall furnish and install all Tridium Niagara (N4) based front end, hardware systems, and equipment to access and interface with a BACnet control system that utilizes unitary controllers to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, etc., and all air handlers, boilers, chillers, and any other listed equipment.
- B. The BAS contractor shall develop, test, and commission all Tridium Niagara (N4) and GUI (Graphic User Interface) software applications for the HVAC control system. Additionally, the BAS contractor shall configure and commission the Ethernet communication network for the HVAC system.
- C. Only BAS contractors that are Factory Authorized to sell and install the Niagara (N4) hardware and software are authorized to bid. The Niagara (N4) Authorized Contractor will have a minimum of three factory trained programmers. The programmers will have completed the Niagara (N4) Certification Program and work as full time employees, not sub-contractors.

- D. It is the owner's express goal to implement an open system that will allow products from various suppliers to be integrated into unified systems in order to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project(s). All Niagara (N4) software licenses shall have the 'accept.station.in="*"'; accept.station.out="*"', accept.wb.in="*" and 'accept.wb.out="*" section of the software licenses. The intent is to insure that the installed Niagara (N4) products may be completely open for integrations. The Owner shall be free to direct the modifications of the any software license, regardless of supplier. In addition, the Owner shall receive ownership of all job specific software configurations documentation, data files, and application-level software developed for the project. This shall include all custom job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use within Niagara (N4) Framework (Niagara (N4)) based controllers and/or servers and any related LAN/ WAN Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the Owner.
- E. Furnish a distributed logic BACnet-based control system, compatible operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.
- F. The Web Server is a flexible network server for multiple connected Niagara controllers. The Web Supervisor is designed to harness the power of the Internet and provide efficient integration and aggregation of the information from multiple controllers. In effect, the Web Supervisor creates a single view of these multiple devices, while providing a powerful network environment with comprehensive database management, alarm management, and messaging services. In addition, the Web Supervisor provides the engineering environment used to set up and manage the systems and the graphical user interface. The software is designed to run on 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better. The browser interface utilizes HTML5. JAVA is not required for the system and graphics to operate. The workstation shall include the following minimal features:
1. Processor: Intel Xeon CPU E5-2640 x64, or better, and is compatible with dual and quad core processors.
 2. RAM: 4 Gb of memory minimum.
 3. Hard disk: minimum 4 TB hard drive and additional space for archiving purposes.
- G. Java Application Control Engine JACE (9000 or latest model at the time of construction)
1. The Tridium JACE Controllers shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the JACE. It shall be capable of executing application control programs to provide:
 - a. Calendar functions
 - b. Scheduling
 - c. Trending
 - d. Alarm monitoring and routing
 - e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
 - f. Integration of LonWorks controller data and BACnet controller data

- g. Network Management functions for all LonWorks and BACnet based devices
2. The JACE (9000) must provide the following hardware features as a minimum:
 - a. Two Ethernet Port -10/100 Mbps
 - b. Two Isolated RS-485 and, if needed, RS -232 ports
 - c. One LonWorks Interface Port - 78KB FTT-10A with Weidmuller connector.
 - d. Two BACnet MS/TP interface Ports
 - e. Power supply 120 VAC
 - f. Battery Backup
 - g. Real-time clock
 - h. Processor: TI AM3352, 1GHz, or greater
 - i. 1 GB Ram, or greater
 - j. 4 GB flash memory.
 - k. 2 GB user storage
 - l. USB flash drive
 - m. Wi-Fi (Client or WAP)
 - n. Operating temperature: -20°C to 60°C
 3. The JACE shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the Tridium JACE shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
 4. The JACE shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.
 5. Event Alarm Notification and actions
 - a. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - b. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 - c. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - d. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - e. Provide alarm generation from binary object "runtime" and log event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
 - f. Control equipment and network failures shall be treated as alarms and annunciated.
 - g. Graphic with flashing alarm object(s)
 - h. The following shall be recorded by the Tridium JACE for each alarm (at a minimum):
 - 1) Time and date
 - 2) Location (building, floor, zone, office number, etc.)

- 3) Equipment (air handler #, accessway, etc.)
 - 4) Acknowledge time, date, and user who issued acknowledgement.
 - 5) Number of occurrences since last acknowledgement.
 - i. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 - j. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 - k. A log of all alarms shall be maintained by the JACE and/or a server (if configured in the system) and shall be available for review by the user.
 - l. Provide a "query" feature to allow review of specific alarms by user defined parameters.
 - m. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 - n. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
6. Data Collection and Storage
- a. The JACE shall have the ability to collect data for any property of any object and store this data for future use.
 - b. The data collection shall be performed by log objects, resident in the Tridium JACE that shall have, at a minimum, the following configurable properties:
 - 1) Designating the log as interval or deviation.
 - 2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
7. All log data shall be stored in a relational database in the Tridium JACE and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
8. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
9. All log data shall be available to the user in the following data formats:
- a. HTML
 - b. XML
 - c. Plain Text
 - d. Comma or tab separated values

10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Server, Oracle Si or Expressa, Hyperion Solutions™ SQL Server.
 11. The Tridium JACE shall have the ability to archive it's log data either locally (to itself), or remotely to a server or other Tridium JACE on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - a. Archive on time of day
 - b. Archive on user-defined number of data stores in the log (buffer size)
 - c. Archive when log has reached its user-defined capacity of data stores
 - d. Provide ability to clear logs once archived
 12. Audit Log
 - a. Provide and maintain an Audit Log that tracks all activities performed on the Tridium JACE. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached the user-defined buffer size. Provide the ability to archive the log locally (to the Tridium JACE), to another Tridium JACE on the network, or to a server. For each log entry, provide the following data:
 - 1) Time and date
 - 2) User ID
 - 3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
 13. Database Backup and Storage
 - a. The Tridium JACE shall have the ability to automatically backup its database. The database shall be backed up based on a user defined time interval.
 - b. Copies of the current database and, at the most recently saved database shall be stored in the Tridium JACE. An onboard micro SD card contains a real-time back up of the system software, database, graphics, license and ability to be relocated to a replacement controller in the event the original controller fails.
 - c. The Tridium JACE database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
 14. A JACE with I/O boards shall not be used for the control of any equipment such as fan coil units, boilers, pumps, etc. A single Unitary or Programmable controller shall manage the control functions for a specific mechanical system.
- H. Ethernet – MS/TP Module
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
 2. All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
 - a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.

- b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).
- I. MS/TP Module
 1. MS/TP module shall support every listed function in this specification and the following.
 2. Building controller MS/TP module communications shall be through BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.
 - a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
 - b. Configuration shall be through RS-232 connection.
- J. Wireless Module
 1. Integrated IEEE 802.11 a/b/g/n
 2. The wireless function comes from the factory disabled and can be turned on or off from a selector switch and can also be turned off through software. It should be turned off when wireless is not being used. Both Client mode and Access Point mode are supported, but cannot be run simultaneously. Broadcasting of the SSID can be turned off. For those using wireless please read the JACE 9000 WiFi document for proper configuration. It supports only WPA-PSK & WPA2-SPK security protocols. It has a single dual band antenna supporting 2.4 Ghz channels 1-11 & 5.8Ghz channels 36, 40, 44, 48, 149, 153, 157, 161, & 165.
 3. Several wireless protocols can be used including: WiFi, Zigbee, Z Wave, EnOcean, 3G, 4G LTE.
- K. Power Supply:
 1. Provide UPS for power supply-backup for each new building global controller (i.e. JACE 9000).
- L. Modbus Module
 1. Modbus Module shall support every function as listed in this specification
 2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
 - a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
 - b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
 - c. EIA-485 connection shall support connection of up to 247 Modbus units.
 - d. Configuration shall be via RS-232 connection.
 3. BACnet Translation
 - a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.

- b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.06 APPLICATION CONTROLLERS – GENERAL

- A. All application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.
- B. All program sequences shall be stored on board controller in memory. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller ten(10) times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.
- C. Provide all application controllers with a minimum of 10% spare points for analog input, analog output, digital input and digital output signals.

2.07 APPLICATION CONTROLLERS –AIR HANDLER OR CENTRAL PLANT

- A. Provide one or more native BACnet application controllers to adequately cover all objects listed in object list. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.
- B. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.
- C. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.
- D. Schedules
 1. The controller shall support a minimum of three (3) BACnet Schedule Objects and have a real-time clock on board with battery backup to maintain time through a power loss.
- E. Logging Capabilities

1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

F. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

- G. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.08 APPLICATION CONTROLLER – UNITARY MECHANICAL EQUIPMENT

- A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

2.09 APPLICATION CONTROLLER – VAV BOX SINGLE DUCT

- A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.
- B. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.
- C. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.10 APPLICATION CONTROLLER – VAV BOX DUAL DUCT

- A. Provide one BACnet application controller for each dual-duct VAV box that adequately covers all objects listed in object list for unit. Systems that use two or more controllers for control of a single dual-duct box shall be rejected. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include two (2) on-board flow sensors, inputs, outputs and self-contained logic program as needed for control of units.

- B. On-board flow sensor shall be microprocessor driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator workstation, portable computers and special hand-held field tools shall not be needed for field calibration.
- C. Provide duct temperature sensors at discharge of cold duct and hot duct for report of data at operator workstation.

2.11 AUXILIARY CONTROL DEVICES

A. Temperature Sensors (TS)

1. Duct air temperature (duct mounted, indoor location)
 - a. Thermistor type with 1/4" stainless steel probe and junction box. 10K ohm, type II, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TF Series, Dwyer Instruments #TE-DFG Series, Kele (Minco) #TT Series, or equal.
 2. Duct air temperature (duct mounted, outdoor location)
 - a. Thermistor type with 1/4" stainless steel probe and weather-tight junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TG Series, Dwyer Instruments #TE-DFW Series, Kele (Minco) #TT Series, or equal.
 3. Outside air temperature (wall mounted location)
 - a. Thermistor type with stainless steel or platinum probe and weather-proof aluminum junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe encased in durable radiation shield with radiation solar shield. Manufacturer: Veris #TO Series, Dwyer Instruments #TE Series, or equal.
 4. Pipe or tank fluid temperature (immersion probe)
 - a. Immersion probe type temperature sensor encased in a corrosion-resistant stainless steel thermowell. Thermistor type with metallic housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Manufacturer: Veris #TIG Series, Dwyer Instruments #TE Series, or equal.
 5. Temperature averaging (coil mounting)
 - a. Thermistor type with bendable copper tubing element water-resistant junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend across coil face at least twice to cover two corners and one midpoint. Mounting of tubing shall utilize Veris #AA64 mounting clips, or equal. Manufacturer: Veris #TA Series, Kele #ACI Series, or equal.
- B. Intelligent Room Temperature Sensor (TS) with LCD Readout
1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use-all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.

2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Humidity Sensors

1. Indoor space humidity (wall mounted inside):
 - a. 1% accuracy thin film capacitive replaceable sensor element, LED display. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series or equal.
2. Outside air humidity (wall mounted outdoors):
 - a. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP-W Series, or equal.
3. Duct air humidity (duct mounted indoor application):
 - a. Humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP-W Series, or equal.
4. Indoor space humidity with temperature (wall mounted inside):
 - a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series, Vaisala #HMW Series, or equal.
5. Outside air humidity with temperature (wall mounted outside):
 - a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP Series, Vaisala #HMS Series, or equal.

6. Duct air humidity and temperature (duct mounted indoor application):
 - a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
 - b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP Series, Vaisala, #HMT Series, or equal.
7. Duct high limit humidity switch (duct mounted indoor application):
 - a. Single-stage duct hygrostat with insertion probe to monitor humidity level with NO and NC contacts. Adjustable relative humidity setpoint range of 35 to 100% RH. SPDT 250 Vac/ 15 amp.
 - b. Manufacturers: Honeywell #H6045A1002, or equal.
- D. Dew Point Sensor (Wall Mounted Indoors):
 1. Dew point transmitter with non-dispersive dual beam infrared sensor in high impact ABS plastic enclosure. Measurement range from 0°F to 80°F (-18°C to 26°C) dew point with altitude correction. 24 VAC input with 0-10 VDC or 4 to 20 mA output as required by controller interface. Accuracy +/- 3.6°F (2°C).
 2. Manufacturers: GE (Telaire) #Vaporstat 9002 or equal.
- E. Dew Point Sensor (Pipe Strap Mounted Indoors):
 1. Early-warning dew point switch to monitor chilled water pipes. Strap on mounting, status light, NO and NC alarm terminals, 24 VAC/0.3 VA.
 2. Manufacturers: Honeywell #HSS-DPS or equal.
- F. CO2 Sensors
 1. Indoor space measurement (wall mounted):
 - a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
 - b. Manufacturers: Veris #CWE Series, Dwyer #CDT Series, or equal.
 2. Outdoor air measurement (indoor duct mounted location):
 - a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
 - b. Manufacturers: Veris #CDE Series, Dwyer #CDT Series, or equal.
- G. CO2, Humidity, Temperature Combined Sensor (Indoor Wall and Duct Mounted)
 1. High impact white ABS plastic enclosure with digital LCD display and adjustable setpoints.
 2. Input power 20 to 30 VDC/24 AC, 100 mA.
 3. Analog output 4-20 mA.
 4. Operating range 32°F to 122°F (0°C to 50°C).

5. CO2 Sensor: Non-dispersive infrared sensor in. Measurement range of 0-5000 ppm with accuracy of +/- 30 ppm.
6. Humidity Sensor: Digitally profiled thin-film capacitive, plus or minus 2% RH. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
7. Temperature Sensor: Thermistor. 2% accuracy thin film capacitive replaceable sensor element.
8. Manufacturers: Veris #CWLP Series or equal.

H. Leak Detector

1. Water leak detector connected to BAS to alarm on detecting the presence of water in the following locations:
 - a. Secondary condensate drip pan below air conditioning air handling units and fan coils located above spaces with electrical and/or electronic equipment.
 - b. Below raised access floors with one sensor per 5,000 square feet (maximum) where water pipes are located below access floor. Or, one sensor per 10,000 square feet (maximum) where no water pipes are located below access floor.
 - c. On the floor adjacent to sump pump(s).
 - d. On the floor of mechanical rooms adjacent to electrical equipment and/or data/electronics equipment rooms. Single point leak detector for locating in condensate drip pan below air conditioning air handling units, under raised floors, in secondary drain pans, on the floor near a sump pump, and in other critical drain locations. Sensing of water shall provide an alarm and send a signal to the BAS or thermostat to shut down operation of the air conditioning compressors.
2. Features:
 - a. Mounting: Base mounted.
 - b. Service: water of conductive fluids.
 - c. Sensing gap: Minimum 1/8" (3 mm) to maximum 1/4" (6 mm).
 - d. Switch type: DPDT relay.
 - e. External power: 1 A @ 24 VAC/DC.
 - f. Audible alarm: 85 dB @ 1' distance (0.3 m).
 - g. Visual indicators:
 - 1) Green to indicate power is supplied.
 - 2) Red to indicate water is detected.
 - h. Temperature limits: 32 to 122°F (0 to 50°C).
 - i. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
 - j. Attached with 1/16" thick double sided adhesive urethane foam tape.
3. Manufacturers: Dwyer #WD3-LP-D2-A, Kele, Veris or equal.

I. Condensate Sensor (Pipe):

1. Solid state condensate detector for locating condensate on chilled water piping. Sensing of water shall provide a signal to the BAS system for control sequence adjustment to raise chilled water temperature.
 2. Features:
 - a. Service: mounted on metallic pipe from 1/2" to 3" in diameter.
 - b. Sensing: 80% to 90% RH (adjustable) surface moisture.
 - c. Switch type: SPST open/close.
 - d. External power: 40 mA at 24 VAC or 20 mA at 12 to 30 VDC.
 - e. Temperature limits: 149°F (65°C).
 - f. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
 - g. Mounting bracket with stainless steel worm gear clamp for attachment.
 3. Manufacturers: Consense #CG-ICM-P or equal.
- J. Differential Pressure Transmitters:
1. Duct Static Pressure Transmitter:
 - a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display.
 - b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series, or equal.
 2. Building Static Pressure Transmitter:
 - a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display.
 - b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series, or equal.
 3. Water differential pressure transmitter:
 - a. Differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure.
 - b. Manufacturers: Veris #PW Series, Dwyer Instruments #MS2, or equal.
- K. Differential Pressure Switches:
1. Filter differential pressure switch for status:
 - a. Adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm, single-pole double-throw type, 1/4" tubing diameter, setting range from 0.08 in. w.c. (20 Pa) up to 20 in. w.c. (5000 Pa), and NEMA-3 enclosure.
 - b. Manufacturers: Dwyer #ADPS Series or equal.
 2. Duct static manual reset high pressure safety switch for supply fan shut down:
 - a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 3.0 to 11.75 in. w.c.
 - b. Manufacturers: Dwyer #1900-10-MR Series or equal.

3. Duct static manual reset high pressure safety switch for return fan shut down:
 - a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 1.40 to 5.5 in. w.c.
 - b. Manufacturers: Dwyer #1900-5-MR Series or equal.

- L. Air Filter Differential Pressure Gauges: (where not supplied by air handling equipment manufacturer):
 1. Dial type, diaphragm-actuated with external zero adjustment and 3-7/8-inch diameter dial.
 2. With two (2) static pressure taps, 2-way valves, tubing and mounting plate (and adjustable signal flag).
 3. Range as recommended by filter manufacturer.
 4. One gauge per filter bank for direct field verification independent of BAS monitoring.
 5. Manufacturers: Dwyer 2000 Series Magnehelic or equal.

- M. Current Sensors
 1. Current sensing switch for constant speed fans and pumps to detect belt loss, coupling shear and mechanical failure:
 - a. Current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
 - b. Manufacturers: Veris #HX08 Series or equal.
 2. Current sensing switch for VFD controlling multiple fans and pumps:
 - a. VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
 - b. Manufacturers: Veris #H614 or equal.
 3. Current sensing switch with fixed trip point for monitoring constant speed direct-drive fans, recirculating pumps or other fixed loads:
 - a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
 - b. Manufacturers: Veris #HX00 Series or equal.
 4. Current sensing transmitter for load trending with proportional 4 to 20 mA output signal:
 - a. Current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket.
 - b. Manufacturers: Veris #H921 or equal.
 5. Current sensing transmitter with relay for fan start/stop control and status monitoring of motors:
 - a. Current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket.
 - b. Manufacturers: Veris #H931 or equal.

- N. Flow Meters – Liquid:

1. Electromagnetic inline flow meter for high accuracy flow measurement of clean fluid in a closed loop:
 - a. Accuracy: +/- 0.25% with bidirectional flow capability. Maintain minimum of three (3X) straight pipe diameters upstream and two (2X) pipe diameters downstream when installed greater than seven (7X) pipe diameters downstream of a pump.
 - b. Electrodes: Two electrodes for flow measurement, one electrode for empty pipe detection, and one electrode for grounding as required by piping system. Constructed of Hastelloy C22, 316 stainless steel, gold, platinum or tantalum.
 - c. Pipe spool: 316 stainless steel.
 - d. Flanges: ANSI B16.5 carbon steel, 304 or 316 stainless steel.
 - e. Housing: NEMA 4X weather tight aluminum enclosure, or carbon steel or stainless steel. Powder coated.
 - f. Power: 120 VAC or 24 VDC.
 - g. Connections: Four programmable digital outputs (minimum), one analog programmable and scalable output, and one digital input.
 - h. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
 - i. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
 - j. Fluid temperature to maximum of 212°F (100°C).
 - k. Manufacturers: Badger Meter #ModMAG M2000, Onicon #FT-3000.

- O. Flow Meters – Steam:
 1. Vortex flow meter, integral 1,000 Ohm platinum RTD for precise temperature measurement, pressure transducer for instantaneous pressure measurement, flow straightener, ANSI class 300 flanges.
 2. Manufacturers: Onicon #F-2600 Series, Preso (Badger Meter) #CV Series or equal.

- P. BTU Meters:
 1. BTU meter with BACnet interface with matched temperature sensors and thermo-wells, NEMA 13 wall mount enclosure, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet.
 2. Manufacturers: Onicon #F-3500 electromagnetic flow meter, or equal by E-Mon D-Mon or Badger.

- Q. Airflow Measuring Arrays
 1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
 2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
 3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.
 4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
 5. Outside Air Measurement:

- a. Provide a minimum outside airflow measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow. On outdoor mounted air handling units, outside airflow measurement station is to be factory mounted on the intake side of the outside air intake (upstream of the damper).
 6. Sensor Performance:
 - a. Fan Installation:
 - 1) Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
 - 2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15°F temperature accuracy.
 - b. Outside Air/duct Installation:
 - 1) Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
 - 2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15°F temperature accuracy.
 7. Transmitter:
 - a. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC. Coordinate signal output with controls installer.
 - b. Transmitter to include an analog airflow gauge to provide direct analog readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
 - c. Device to provide switch selectable Modbus or Johnson N2 outputs.
 - d. Device to be UL listed.
 - e. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown-outs.
 - f. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
 - g. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
 - h. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
 - i. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-28.8°C to 48.8°C).
 - j. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
 - k. The Sensors shall be calibrated to NIST traceable standards.
 8. Manufacturers: Ebtron, Paragon Controls, Dynasonics, or equal.
- R. LED Pilot Lights

1. Provide wall mounted pilot lights to indicate when operable windows may be opened or closed based on outdoor weather conditions as determined by BAS. Mount adjacent to main access door serving space with operable windows or adjacent to light switch, as shown on Architectural or Mechanical drawings. Coordinate final placement of pilot lights and color of cover plate with Owner's Representative.
2. Polycarbonate or steel wall box.
3. Wall plate color to match wall color. Color options to include: ivory, white, black or stainless steel.
4. Continuous color indication. LED lights, 20-25 mm diameter. One green light located above one red light.
5. Voltage as selected by BAS installer, 12-volt or 24-volt, 20 mA, maximum.
6. Manufacturers: Signaworks #WP22 Series or equal.

S. Flow Switch

1. Paddle type vane flow switch for insertion into pipe sizes 1" to 8". Forged brass body, stainless steel vane, and tin-bronze bellows. Maximum operating temperature to 230°F (110°C) and maximum operating pressure to 145 psig (10 bar). NEMA 4 enclosure, SPDT snap switch, 250 VAC (max). Connection using 1" male NPT or BSPT. Switch must be installed vertically on a horizontal pipe run.
2. Manufacturers: Dwyer #FS-2, or equal.

2.12 ACTUATORS

A. Electronic Actuators:

1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
4. Overload protected electronically throughout rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism
6. Electronic Fail-Safe Operation: Incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10% increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
7. Power Requirements (Spring Return): 24-V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
8. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
9. Temperature Rating: -22 to +122°F.
10. Housing: Minimum requirement NEMA type 2 mounted in any orientation.
11. Agency Listings: ISO 9001, cULus, CE or CSA
12. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
13. Manufacturers: Belimo, Siemens, Honeywell, Keystone #777, or equal.

- B. Actuators with torque requirements exceeding 360 inch-pounds:
1. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
 2. Coupling: ISO 5211 mounting standards.
 3. Overload Protection: A self-resetting thermal switch embedded in the motor.
 4. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure
 5. Power Requirements: 24VAC, 120VAC, or 230VAC single phase.
 6. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
 7. Temperature Rating: -22 to +122°F.
 8. Duty Cycle Rated 75% minimum.
 9. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
 10. Agency Listing: ISO, CE, CSA
 11. The manufacturer shall warrant for 2 years from the date of production.
 12. Manufacturers: Belimo, Siemens, Honeywell, or equal.

2.13 CONTROL VALVES

- A. Manufacturer: Belimo, Siemens, Honeywell, or equal.
- B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).
- C. Control Valve Actuators:
1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
 2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.
 3. Non-spring return actuators shall have manual override
 4. Spring return actuators of 90 inch-pounds or above shall have manual override.
- D. Control Valves:
1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
 2. Sizing (Water):
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
 - b. Two-Way Modulating: Size for a pressure differential across the valve of 4 psi at design flow, or twice the load pressure drop at design flow.
 - c. Three-Way Modulating: Size for a pressure differential across the valve of not more than 4 psi at design flow
 3. Sizing (Steam):

- a. Two-Position: Line size or sized using 10% of inlet gauge pressure.
 - b. Modulating: 15 psig or less inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 15 psig inlet steam pressure the pressure drop shall be 42% of the inlet absolute pressure.
4. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
 5. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.
- E. Pressure Independent Control Valves:
1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc for equal percentage characteristic.
 2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
 3. The control valve assembly shall have an integral magnetic flow meter Magnetic flow meter to accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
 4. Flow Characteristics: NPS 1/2" through 2" Equal percentage characteristic. NPS 2-1/2" through 6" capable of Equal percentage or Linear characteristic (field programmable).
 5. All proportional actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
 6. Actuators for 3-wire floating (tri-state) and on 2 position (on/off) on 1/2" to 1" pressure independent control valves shall fail in place.
 7. Water Coil optimization 2-1/2" through 6" shall be accomplished by utilizing an energy meter (a pressure independent control valve assembly) with two integral temperature sensors providing feedback of coil inlet and coil outlet water temperature; and integral magnetic flow meter for control and to provide actual analog flow feedback. Valve assembly to have built in intelligence to control pressure independently and a Delta T Manager mode to mitigate low delta T syndrome by referencing an internally programmed design delta T setpoint. Valve assembly shall be capable of communicating data by means of BACnet MS/TP, BACnet I/P and TCP IP. Data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr. Valve assembly shall be capable of trending and storing up to 13 months of data on the actuator. Trended data on actuator to be retrievable via TCP IP or direct connect and download to *.csv file format.
 8. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
 9. The control valve shall require no maintenance and shall not include replaceable cartridges.

10. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with strainer/shut-off valve/drain with pressure/temperature test ports. The return side shall contain a union fitting with a pressure/temperature test port, pressure independent control valve, and integrated isolation ball valve/manual air vent with a pressure/temperature test port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A braided stainless flexible hose shall be provided for each coil supply and return connection for all pipe packages.
- F. Characterized Control Valves:
1. NPS 1/2" and smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi WOG Water oil gas, chrome plated brass Stainless steel stem is an option ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
 2. NPS 1" through 2": Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
 3. NPS 2-1/2" through 6": GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
 4. Flow Characteristics: Equal percentage characteristics.
 5. Six-way control valve used for chilled beam applications shall have the following characteristics:
 - a. NPS 1/2" and 3/4": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
 - b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.
- G. Butterfly Valves – Resilient Seat:
1. NPS 2 to 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. The shaft shall be supported at four locations by RPTFE bushings.
 2. NPS 14 and Larger: Valve body shall be full lugged cast or ductile iron, 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.
 3. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
 - b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position and a design velocity not to exceed 12 feet per second.

4. Close-Off Pressure Rating: NPS 2-12" 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

H. Butterfly Valves – High Performance:

1. Valve body shall be full lugged carbon steel ANSI Class 150 [300] body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 150300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2" insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
2. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
 - b. Modulating: 4 psig, or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.
3. Flow Characteristics: Modified equal percentage, unidirectional.
4. Close-Off Pressure Rating: 150 psi bubble tight shut-off.
5. Media Temperature Range: ANSI Class 150 limitations.
6. Max Differential Pressure: 285 psi @ 100°F for ANSI 150 (725 psi @ 100°F for ANSI 300).

I. Equipment Isolation Valves:

1. Slow Closing/Quick Opening Solenoid Valve (2-Way/2-Position), 1/2" to 2-1/2":
 - a. Class 125, brass body, stainless steel core, snubber slows disc closing to protect system against water hammer, minimum operating pressure differential 5 psi, 120 VAC input, normally closed (closed when deenergized). Lead-free construction and UL/NSF compliant. Valve shall full stroke close in 4 to 10 seconds and open immediately when energized. Manufacturers: Asco Redhat #8221 or equal.
2. Butterfly Valves, 2-1/2" and larger:
 - a. Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. The shaft shall be supported at four locations by RPTFE bushings.
 - b. Valve actuator with integrated linkage for 90° degree rotation and visual position indicator. Power supply with input voltage from 24 to 240 VAC. Power consumption in operation 20 watts and resting power consumption of 6 watts maximum. Adjustable running time of 30 to 120 seconds for full stroke. Ambient humidity to 95% RH non-condensing and operating temperature from -22°F to 122°F (-30°C to 50°C). Die cast aluminum Type 4X enclosure. Open/close or floating point operation as required by system operation. Manufacturer: Belimo #PR Series or equal.

2.14 ENERGY VALVE

1. NPS 1/2" through 2":

- a. 2-way characterized control valve with tight close-off. Nickel-plated forged brass body rated at no less than 360 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and flow characterizing disc.
 - b. Non-spring return or electronic fail-safe actuator with analog input and output
 - c. Ultrasonic flow meter with temperature and glycol compensation.
 - d. Supply and return temperature sensors with thermowells and pipe fittings.
2. NPS 2-1/2" through 6":
- a. 2-way characterized control valve with tight close-off. GG25 cast iron body according to ANSI Class 125 or Class 250 per system pressure class, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125/250 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
 - b. Non-spring return or electronic fail-safe actuator with analog input and output
 - c. Magnetic flow sensor.
 - d. Supply temperature sensor with thermowell.
 - e. Return temperature sensor embedded.

B. Manufacturer: Belimo.

2.15 DOMESTIC WATER SECURITY VALVES

- A. Scope: connect to BAS for automatic opening and closing of domestic cold water supply to building.
- B. Control Valve Actuator:
1. High torque actuator, fast opening and closing to control incoming domestic cold water service.
 2. NEMA 6P waterproof enclosure.
 3. UL listed.
 4. Power supply input: 100–240 volts, 60 Hz, 1 amp maximum. Output 18 volts, 2.22 amps.
 5. BAS feedback signals for valve open or closed.
 6. 12 VDC trigger contact to open valve.
- C. Control Valve:
1. 316 stainless steel, 3-piece construction for body, ball and stem.
 2. Equipped with a manual handle for emergency override.
 3. Pressure rated to 600 psi, minimum.
 4. Full port ball valve.
 5. Threaded for sizes 1/2" to 2".
- D. Low lead and certified for potable water use per UPC and NSF/ANSI 61.
- E. Manufacturer: Automatic Security Valves, or equal.

2.16 WIRELESS SYSTEM

A. Architecture and Communications:

1. Wireless equipment controllers and control devices shall conform to IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Equipment shall also comply with the following standards:
 - 1) UL 916: Energy Management Equipment
 - 2) UL 94: The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
 - 3) UL 873: Temperature regulating and indicating equipment
 - 4) ZigBee Building Automation
 - 5) BACnet Tunneling
2. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
3. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to ensure reliable operation.
4. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
5. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
6. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.
7. The system devices shall use direct sequence spread spectrum RF technology.
8. The system devices shall operate on the 2.4 GHZ ISM Band.
9. The system devices shall be FCC compliant to CFR Part 15 subpart B Class A.

B. Service Tools:

1. To support network setup and troubleshooting, service tools shall display link quality and hop quantities for each wireless device.
2. Wireless service tool access to communication link shall be provided to minimize installation and troubleshooting labor.

C. Construction:

1. Devices such as sensors, receivers and signal coordinators, intended to be installed in a return air plenum, shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB. Wall mounted devices may be assembled in NEMA-1 plastic enclosures.

D. Wireless Field Bus System:

1. The system shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for BACnet devices at multiple system levels. This includes communications from field controllers to sensors and from sensors to field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.

2. The field bus coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a coordinator for initiation and formation of the network
 - a. The coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
 - b. The coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
 - c. The coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
3. A wireless field bus router shall be used with any controller and field device to provide a wireless interface to supervisory devices and associated wireless mesh room temperature sensors.
 - a. The router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - b. The router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
 - c. The router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

E. Wireless Room Temperature Sensors:

1. Wireless space sensors shall be capable of continuous operation in the following conditions:
 - a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
 - b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
2. Wireless room temperature sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated router.
 - a. The sensors shall be available with:
 - 1) Warmer/cooler setpoint adjustment or no setpoint adjustment.
 - 2) Setpoint adjustment scale: 55°F to 85° F (minimum range).
 - b. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in the schedules.
3. Features:
 - a. The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
 - b. To check for proper operation, wireless space temperature sensors shall include signal strength on the space sensor display.
 - c. To support use by the physically impaired, the wireless space sensor shall be a minimum font size of 12 points, and the LCD model shall be readable in low light conditions.
 - d. An optional 2% relative humidity sensors module shall be available for humidity control applications to minimize the need for wired sensors, and shall not shorten typical battery life to less than 15 years.

- e. Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2% humidity module for use in either model above. The field configurable models shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
 - f. The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
 - g. The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.
 - h. The wireless space sensor shall include security screws to protect against theft.
4. Accuracy:
- a. To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is rapidly changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5°F (+/- 0.28°C).
- F. Wireless Communications Interface:
- 1. Wireless communication devices and receivers shall be capable of continuous operation in the following conditions:
 - a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
 - b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
 - 2. Features:
 - a. Wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.
- G. Many-To-One Wireless Receiver:
- 1. The Many-To-One System Receiver shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple wireless room temperature sensors.
 - 2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - 3. The receiver shall be capable of communication with sensors up to a distance of 200 Feet.
 - 4. The receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - 5. The receiver shall have LED indicators to provide information regarding the following conditions:
 - a. Power: on/off.
 - b. Ethernet: receiver activity/no activity.

- c. Wireless Normal Mode: transmission from sensors/no transmission.
- d. Wireless Rapid Transmit Mode: no transmission/weak signal/adequate signal/excellent signal.
- e. Ethernet Connection: No connection/10Mbps connection/100Mbps connection
- f. Network Activity: No network activity/half-duplex communication/full-duplex communication.

H. One-to-One Wireless Receiver:

- 1. The One-To-One Wireless Receiver shall receive wireless radio frequency (RF) signals containing temperature data from multiple wireless room temperature sensors and communicate this information to field controllers via the communication bus.
- 2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
- 3. The receiver shall be capable of communication with from one to five sensors up to a distance of 200 Feet.
- 4. The receiver shall have LED indicators to provide information regarding the following conditions:
 - a. Power.
 - b. Communication Bus: Receiver activity/no activity.
 - c. Wireless RF: Transmission from sensors/no transmission.
 - d. Wireless Rapid Transmit Mode: No transmission/weak signal/adequate signal/excellent signal.

I. System Tools:

- 1. Wireless Space Sensor Installation and Configuration Tools
 - a. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the contractor use for system installation and commissioning for the duration of the warranty period.
 - b. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the Owner for permanent possession for ongoing system maintenance and trouble shooting.

2.17 ENCLOSURES

- A. All controllers, power supplies and relays shall be mounted in enclosures.
- B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment.
- C. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.
- D. Outdoor enclosures shall be NEMA 3R or NEMA 4X, as necessary for the site.
- E. Enclosures shall have hinged, locking doors.
- F. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

2.18 PROGRAMMABLE THERMOSTAT

- A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
 - 1. Manufacturers: shall match the manufacturer of the specified BAS system.
- B. Minimum thermostat features shall include, but not limited to, the following:
 - 1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
 - 2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
 - 3. The setback override shall be activated by a single button, and deactivated on demand.
 - 4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
 - 5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F.
- C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
 - 1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
 - 2. Emergency Heat switch will be provided on the touch screen when set in heat pump mode.
- D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.
- E. Controls shall be capable of alternating compressor starting sequence with a built-in lead-lag operating logic.
 - 1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.
- F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
 - 1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.
- G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

- H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- B. Notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work.
- C. Do not begin work until all unsatisfactory conditions are resolved.

3.02 INSTALLATION (GENERAL)

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.03 LOCATION AND INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum three (3) feet of clear access space in front of units. Obtain approval on locations from Owner's Representative prior to installation.
- B. Wall mounted temperature sensors will typically be mounted directly above or below light switches and comply with ADA height requirements. Coordinate with Owner, Architect and other trades to assure proper mounted locations prior to installation.
- C. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.
- D. Identify all equipment and panels. Provide permanently mounted tags for all panels.
- E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.04 CONDUIT

- A. Conduit Requirements: all conduit shall with comply with minimum requirements of local authority having jurisdiction.
 - 1. Low voltage wiring in concealed areas may be plenum rated. Low voltage wiring in exposed areas shall be enclosed in conduit.
 - a. All low voltage wiring exposed to weather shall be installed in conduit.

- b. Low voltage wiring in exposed areas, such as in mechanical, electrical, or service rooms, shall be installed in EMT conduit up to 10 feet above finished floor.
 - 2. All low voltage control wiring in critical facilities and critical locations shall be enclosed in conduit.
- B. Provide rigid conduit for low voltage wiring in walls for all wall mounted sensors, CO2 sensors, humidity sensors, etc. Conduit shall be run to 6" (minimum) above the ceiling and shall terminate with a bushing installed on the conduit end. Flexible conduit shall not be used.
- C. Provide conduit for low voltage wiring above inaccessible ceilings.
- D. Conceal all conduits, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 12 inches (30 cm) from high-temperature equipment (i.e.-such as flues or high temperature pipes).
- E. Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.
- F. Secure conduits with conduit clamps fastened to the structure and spaced according to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.
- G. Size of conduit and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

3.05 LOW VOLTAGE INTERLOCKING AND CONTROL WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All low-voltage wiring shall meet NFPA-70 (NEC) Article 725 Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- C. Do not install Class 2 wiring (greater than 100 volts and protected by overcurrent device not over 20 amperes) in conduits containing Class 1 wiring (not exceeding 30 volts and 1000 volt-amperes). Boxes and panels containing line voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- D. Unless otherwise noted, power wiring for all valve and damper actuators is Class 2. If the BAS contractor desires to substitute 120-volt actuators, the BAS contractor shall coordinate directly with the General Contractor and Electrical Contractor to provide all 120-volt wiring and conduit at no additional cost to the Owner.
- E. Contractor shall provide step-down transformers as necessary.
- F. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of vertical conduits.
- G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block. Wire nuts are not acceptable.

- H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- I. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- J. Use color-coded conductors throughout with conductors of different colors.
- K. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- L. The contractor shall terminate all communications, control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

3.06 COMMUNICATION WIRING

- A. The contractor shall adhere to the wiring requirement previously listed.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in conduits and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. The network shall use shielded, twisted-pair or stranded cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Wire gauge and wire type shall be sized and coordinated with manufacturer load requirements and lengths of runs.
 - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - 4. An MS/TP EIA-485 network shall have no T connections.

- K. All Ethernet cabling, routers, hubs and switches for connecting 230900 furnished and installed control panels, servers and clients to the building Owner's Ethernet network are the responsibility of the BAS contractor.

3.07 MOTORIZED DAMPERS

- A. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, return air opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.
 - 1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.
 - 2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

3.08 FIELD SERVICES

- A. Prepare and start logic control system under provisions of this section.
- B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation. Provide all labor and services as necessary to support testing and verification by third party commissioning authority.
- C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.
- D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.09 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:
 - 1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on optical media and as 11" x 17" prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
 - 3. Operation and Maintenance (O & M) Manual.
 - 4. As-built versions of submittal product data.
 - 5. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - 6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
9. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
10. Graphic files, programs, and database on magnetic or optical media.
11. List of recommended parts with part numbers and suppliers.
12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
14. Licenses, guarantees, and warranty documents for equipment and systems.
15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

3.10 TRAINING

- A. Provide application engineer to instruct Owner in operation of systems and equipment.
- B. Provide system operator's training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.
- C. Provide on-site training above as required, up to 16 hours as part of this contract.
- D. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the Owner.

3.11 DEMONSTRATION

- A. Demonstrate complete operating system to Owner's Representative.
- B. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING, VALVES AND SPECIALTIES

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the following:
1. Pipe and Fittings:
 - a. Chilled water piping aboveground
 - b. Condenser water piping aboveground
 - c. Heating water piping aboveground
 - d. Temperature and Pressure relief
 - e. Radiant heating piping
 - f. Refrigerant piping
 - g. Boiler feed
 - h. Cold condensate drainage piping (also reference Division 22 for plumbing piping)
 2. Valves:
 - a. HVAC Service Valves (125 psig max. working pressure)
 - b. HVAC Service Valves (250 psig max. working pressure)
 - c. Check Valves
 - d. Balancing Valves (125 psig working pressure)
 - e. Combination HVAC terminal unit valve line sets
 - f. Hydronic Service Pressure Reducing Valves
 - g. Hydronic Service Pressure Relief Valves
 3. Expansion tanks
 4. Air separators
 5. Chemical pot feeder
 6. Hydronic water buffer tank
 7. Piping specialties:
 - a. Thermometers

- b. Pressure gauges
- c. Expansion Compensators
- d. Pipe escutcheons
- e. Strainers
- f. Drip pans
- g. Air vent
- h. Air elimination valves
- i. Dielectric unions and flanges
- j. Unions
- k. Flanges
- l. Pipe sleeves
- m. Sleeve seals
- n. Valve boxes
- o. Pipe coating

B. In addition, provide the following:

- 1. Furnish accessories and labor for flushing and cleaning HVAC piping.
- 2. Install water treatment systems.
- 3. Furnish material, accessories and labor for glycol antifreeze charging of new HVAC piping.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Division 01: General Requirements.

B. Division 22: Plumbing.

C. Division 23: Mechanical.

- 1. Section 23 05 00 - Basic HVAC Materials and Methods.
- 2. Section 23 05 48 - Vibration Isolation for Piping Ductwork and Equipment.
- 3. Section 23 05 49 - Seismic Restraint for Piping Ductwork and Equipment.
- 4. Section 23 05 93 - Testing, Adjusting and Balancing.
- 5. Section 23 07 19 - HVAC Piping Insulation.
- 6. Section 23 21 14 - Hydronic Underground Piping.
- 7. Section 23 21 23 - Hydronic Pumps.
- 8. Section 23 25 00 - HVAC Water Treatment.
- 9. Section 23 52 00 - Non-Condensing HW Boilers.
- 10. Section 23 52 16 - Condensing Boilers.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:

1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
5. All HVAC work shall comply with the Americans with Disabilities Act (ADA).
6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

C. Product Control

1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
2. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. If project conditions require deviations from arrangement or location indicated to meet existing conditions or due to interference with work of other trades, such deviations as offsets, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
3. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.
5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.

7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
 8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions conflict with the Drawings and Specifications, submit these conflicts to the Owner's Representative and receive clarification before installing the work.
 9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.
 10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
 11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.
- D. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- E. Welding Standards:
1. Welding Qualifications:
 - a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The welder must maintain their certification to show qualified welding experience every six months. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.
 2. Welding Procedures:
 - a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
 - b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."
- F. Pressure Piping Standards
- a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.

- b. Comply with ASME B31.9 Building Services Piping standard for the following services:
 - 1) Conveying fluid between 0°F (-18°C) to 250°F (121°C).
 - 2) Fluid pressure less than 350 psig.
- c. Comply with ASME B31.3 Process Piping standard for the following services:
 - 1) Conveying fluid above 250°F (121°C).
 - 2) Toxic or flammable fluids.

1.05 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, flow capacity, pressure setting, tolerances etc.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.
- C. Grooved joint couplings and fittings shall be shown on drawings and product submittals and be specifically identified with the applicable mechanical coupling style number.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.
- C. Provide the following additional extended warranty requirements that apply to piping with mechanical type joints and fittings, such as grooved or pressed/compression type fittings.

1. The warranties and corrective obligations provided under this section: (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer; (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced; and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.
2. Contractor and Manufacturer warrant that, for a period of ten (10) years from the date of Substantial Completion, the entire system, including but not limited to the fittings and joints, will conform to the requirements of the Contract Documents, will be free from defects, and will not leak.
3. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
 1. All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Owner's Representative prior to bidding.

OR
 2. Upon request, the Owner's Representative shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.
- B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.
- C. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.
- D. Hydronic Piping Pressure Classifications:
 1. Chilled Water, Condenser Water, Heating Water and Condensate:
 - a. "Normal Pressure" shall be working fluid pressure up to 125 psig.
 - b. "High Pressure" shall be working fluid pressure up to 250 psig.

2.02 PIPE AND FITTINGS

- A. Chilled Water Piping: (Aboveground)
 1. Steel Pipe:

- a. Pipe Material: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter. Standard weight black steel for 12" and larger.
 - b. Fittings:
 - 1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded for pipe 2-inch and under; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
 - 2) Steel high pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
 - c. Grooved Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms.
 - 1) Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
 - a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Manufacturers: Victaulic rigid Style 107N ("Installation Ready" stab-on design 2" to 12") and 07 (standard coupling 1" to 12"), or flexible Style 177N ("Installation Ready" stab-on design 2" to 8") and 77 (standard coupling 3/4" to 24") or rigid style P07 coupling or P10 elbow (QuickVic Installation-Ready 1/2" to 1"), Tyco-Grinnell rigid Fig. 772 or flexible Fig 705 and 707, or Anvil-Gruvlok FIG 7001 flexible or FIG 7401 rigid. Other types of fittings may be submitted for review for use in mechanical rooms or exterior to the building on a case-by-case basis.
 - b) Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Manufacturers: Victaulic Style 107 or 07, Tyco-Grinnell Fig 772, or Anvil-Gruvlok FIG 7401.
 - c) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Manufacturers: Victaulic Style 177, 077, or W77, Tyco-Grinnell 705 and 707, or Anvil-Gruvlok FIG 7001.
 - d) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be EPDM pressure responsive synthetic rubber rated for service from -30°F to +230°F (-34°C to +110°C). Manufacturers: Victaulic Grade "EHP" or better.
 - e) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
 - f) All grooved couplings, fittings, valves and specialties used on project shall be the products of a single manufacturer.
 - g) Grooved manufacturer must be ISO 9001 certified.
2. Copper Tubing:

- a. Pipe Material: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure aboveground.
- b. Fittings:
 - 1) ASME B16.23 cast brass or ANSI/ASME B16.22 wrought copper with the following connection methods.
 - 2) Soldered or brazed: ASTM B32, solder, Grade 95TA.
 - h) 2" and smaller: Make connections using 95%-5% tin-antimony solder joints aboveground or sil-fos brazing.
 - i) 2-1/2" and larger: Sil-Fos brazing or flanged.
- c. Grooved Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical interior areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms.
 - 1) Grooved copper tubing connection system. Manufacturers: Victaulic CTS, Tyco-Grinnell, or Gruvlok for aboveground joints.
 - 2) Grooved couplings. Manufacturers: Victaulic Style 607 (Quick Vic), Tyco-Grinnell Fig. 672, Gruvlok FIG 6400. Other types of fittings may be submitted for review for use in mechanical rooms or exterior to the building on a case-by-case basis.
 - 3) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be EPDM pressure responsive synthetic rubber rated for service from -30°F to +230°F (-34°C to +110°C). Manufacturers: Victaulic Grade "EHP" or better.
 - 4) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.
 - 5) Grooved manufacturer must be ISO 9001 certified.
 - 6) Flaring of copper tube to IPS dimensions is unacceptable.
- d. Pressfit Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical interior areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms.
 - 1) Pressed copper tubing connection system as an alternate for 2-1/2" and smaller chilled water piping system for normal pressure systems. Systems shall be rated for maximum pressure to 200 psi and operating temperature range from 0°F to 230°F continuous.
 - j) Manufacturers: Victaulic Vic Press 304™ pipe, couplings, and fittings. Pipe shall be ASTM A312, Schedule 10S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring seals or better.
 - k) Manufacturers: Viega ProPress with Smart Connect fittings and couplings. Copper tubing shall conform to ASTM B75 or ASTM B88. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements shall be EPDM or better.

B. Condenser Water Piping (Aboveground)

1. Steel Pipe:

- a. Pipe Material: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter. Standard weight black steel for 12" and larger.
 - b. Fittings:
 - 1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded for pipe 2-inch and under; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding high pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
 - c. Grooved Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms.
 - 1) Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
 - i) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Manufacturers: Victaulic rigid Style 107N ("Installation Ready" stab-on design 2" to 12") and 07 (standard coupling 1" to 12"), or flexible Style 177N ("Installation Ready" stab-on design 2" to 8") and 77 (standard coupling 3/4" to 24") or rigid style P07 coupling or P10 elbow (QuickVic Installation-Ready 1/2" to 1"), Tyco-Grinnell rigid Fig. 772 or flexible Fig 705 and 707, or Anvil-Gruvlok FIG 7001 flexible or FIG 7401 rigid. Other types of fittings may be submitted for review for use in mechanical rooms or exterior to the building on a case-by-case basis.
 - m) Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9. Manufacturers: Victaulic Style 107 or 07, Grinnell Fig 772, or Gruvlok FIG 7401.
 - n) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Manufacturers: Victaulic Style 177, 077, or W77 Grinnell 705 and 707, or Gruvlok FIG 7001.
 - o) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be EPDM pressure responsive synthetic rubber rated for service from -30°F to +250°F (-34°C to +110°C). Manufacturers: Victaulic Grade "EHP" or better.
 - p) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
 - q) All grooved couplings, fittings, valves and specialties used on project shall be the products of a single manufacturer.
 - r) Grooved manufacturer must be ISO 9001 certified.
2. Copper Tubing:
 - a. Pipe Material: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure aboveground.

- b. Fittings:
- 1) ASME B16.23 cast brass or ANSI/ASME B16.22 wrought copper with the following connection methods.
 - 2) Soldered or brazed: ASTM B32, solder, Grade 95TA.
 - s) 2" and smaller: Make connections using 95%-5% tin-antimony solder joints aboveground or sil-fos brazing.
 - t) 2-1/2" and larger: Sil-Fos brazing or flanged.
- c. Grooved Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical interior areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms.
- 1) Grooved copper tubing connection system for aboveground joints. Manufacturers: Victaulic CTS, Tyco-Grinnell, or Gruvlok.
 - 2) Grooved couplings. Manufacturers: Victaulic Style 607 (Quick Vic), Grinnell Fig. 672, or Gruvlok FIG 6400.
 - 3) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be EPDM pressure responsive synthetic rubber rated for service from -30°F to +250°F (-34°C to +110°C). Manufacturers: Victaulic Grade "EHP" or better.
 - 4) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.
 - 5) Grooved manufacturer must be ISO 9001 certified.
 - 6) Flaring of copper tube to IPS dimensions is unacceptable.
- d. Pressfit Fittings – Alternate for use in mechanical rooms, exterior to the building and routing in non-critical interior areas. Not allowable for placement above or in electrical, computer or low-voltage equipment areas or rooms. Pressed copper tubing connection system as an alternate for 2-1/2" and smaller condenser water piping system for normal pressure systems. Systems shall be rated for maximum pressure to 200 psi and operating temperature range from 0°F to 230°F continuous.
- (a) Manufacturers: Victaulic Vic Press 304™ pipe, couplings, and fittings. Pipe shall be ASTM A312, Schedule 10S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring seals or better.
 - (b) Manufacturers: Viega ProPress with Smart Connect fittings and couplings. Copper tubing shall conform to ASTM B75 or ASTM B88. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements shall be EPDM or better. eating Water Piping (Aboveground): Steel Pipe: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter, and Std. Wt. Black steel for 12" diameter and greater.
- e. Fittings:
- 1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding

- 2) Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
 - f. Grooved Fittings – Alternate for use in mechanical rooms and exterior to the building. Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
 - 1) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Manufacturers: Victaulic rigid Style 107 (“Installation Ready” stab-on design) and 07 (standard coupling), or flexible Style 177 (“Installation Ready” stab-on design and 77 (standard coupling), or equal.
 - 2) Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 an. Manufacturers: Victaulic Style 107 or 07, or equal.
 - 3) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Manufacturers: Victaulic Style 177, 077, or W77, or equal.
 - 4) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be EPDM pressure responsive synthetic rubber rated for service from -30°F to +250°F (-34°C to +110°C). Manufacturers: Victaulic Grade “EHP” or better.
 - 5) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
 - 6) All grooved couplings, fittings, valves and specialties for this project shall be the products of a single manufacturer.
 - 7) Grooved manufacturer must be ISO 9001 certified.
 3. Copper: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure aboveground.
 - a. Fittings:
 - 1) Copper system: ANSI B16.22, wrought copper with the following connection methods.
 - a) 2” and smaller: Make connections using 95%-5% tin-antimony solder joints or sil-fos brazing.
 - b) 2-1/2” and larger: Sil-Fos brazing or flanged.
- C. Boiler Feed Piping:
 1. Steel (normal pressure application of 100 psig or less working pressure): Pipe: ASTM A53 Grade B, Schedule 80 black steel.
 2. Fittings: Steel normal pressure application of 150 lb. rating (minimum). ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
 3. Joints: 2” and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2” and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.
- D. Temperature and Pressure Relief Valve Discharge Piping:
 1. Hydronic Water System (150 psig and 212 deg. F. maximum):

- a. Pipe: Type M or L copper ASTM B88
- b. Pipe: Schedule 40 black steel, ASTM A53 Grade B.
- c. Fittings: ANSI B16.22, wrought copper.
- d. Fittings: 150 lb. rating. ANSI B16.3, malleable iron threaded.
- e. Joints: ANSI B16.22, wrought copper, with 95%-5% tin-antimony solder joints.
- f. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

2.03 VALVES-GENERAL

- A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.
- B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of balancing valve or circuit setter. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
- C. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.
- D. Acceptable Manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
 1. Gate or Butterfly: Crane, Bray, Hammond, Anvil-Gruvlok, Milwaukee, Victaulic, Tyco-Grinnell, Keckley, Keystone, Bray, Keystone K-Lok, Nibco, or equal.
 2. Ball and Drain Valves: Apollo, Hammond, Milwaukee, Nibco, Victaulic, Tyco-Grinnell, Bray, Anvil-Gruvlok, Bray, Keystone K-ball, Watts, or equal.
 3. Check: US Valve, Metraflex, DeZurik, Victaulic, Milwaukee, Mueller, Nibco, Apco, Cla-Val, Prince, American Wheatley Products, or equal.
 4. Hydronic System Pressure Reducing Valves: Cash-Acme, Cla-Val, Watts, or Wilkins.
 5. Hydronic Pressure Relief Valves: Cash-Acme, Cla-Val, Watts, Wilkins, or equal.
 6. Hydronic Balancing Valves and Circuit Setters: Pro Hydronic Specialties, Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, Nibco (globe style), Victaulic/Tour & Anderson, Bray, Anvil-Gruvlok, Oventrop, Tyco-Grinnell, or equal.
- E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.
- F. Operators:
 1. Provide 90-degree lever operator for ball valves.
 2. Provide 90-degree locking lever operator for butterfly valves up through 5" size. For 6" size and greater, provide gear operator and handwheel.
 3. Provide insulated valve stem extension for lever-operated valves on insulated piping, so handle will clear insulation and jacket. Provide valve manufacturer's plastic insulated housing where available as valve option.

4. Provide chain operated sheaves on valves sizes 2-1/2" and larger, located more than ten (10) feet from floor in equipment room areas. Provide chain and extend down to five (5) feet above floor and hook clips on chain arranged to clear walking aisles.

G. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
2. Bypass: On valves 6" and larger comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving. Provide a 3-valve bypass, minimum 1" size, to consist of two threaded shut-off valves and a plugged drain valve.
3. Drain: Comply with MSS SP-45 and provide 3/4" threaded pipe end with cap and chain.
4. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
5. Grooved: Valves shall be joined using grooved joint couplings of the same manufacturer. Copper tubing valve grooved ends shall be copper tubing sized.
6. Vic Press 304™: Valves complete with Vic Press 304™ ends.
7. Threaded: Valve ends complying with ANSI B2.1.
8. Solder-Joint: Valve ends complying with ANSI B16.18.
9. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

Valve Comparison			
Item	Soft Seated Ball Valve	Resilient Seated Butterfly Valve	Iron or Bronze Gate Valves
Sealing	Positive "Bubble tight" per MSS standards	Positive "Bubble tight" per MSS standards	Allowable leakage rate per MSS
Weight	Lighter than gate - could lead to lower overall piping costs	Lighter than gate - could lead to lower overall piping costs	Heavy vs Lug BFV
Size	Lower profile for better clearance (approx 1/6 space vs gate)	Lower profile for better clearance (approx 1/6 space vs gate)	Need for room especially considering rising stem
Application	On-off or throttling capabilities(except steam)	On-off or throttling capabilities	On-Off only
Operation	1/4 turn/90 degree operation	1/4 turn/90 degree operation	Multi-turn/many revolutions needed
Maintenance	Virtually maintenance free	Virtually maintenance free	Requires routine maintenance (packing adjustment, etc)
Position Indication	Easy to read via handle position (or via standard gear operator)	Easy to read via handle position (or via standard gear operator)	Difficult to know without a special indicator

2.04 HVAC SERVICE VALVES (MAXIMUM 125 PSIG SYSTEM WORKING PRESSURE)

A. Ball Valves, 2" and Smaller:

1. 2-piece bronze body, 600 psi rating, stainless steel or chrome plated brass ball, Teflon seat, brass or stainless steel stem, steel handle, full port. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #BA-400 or equal. Soldered copper pipe: Milwaukee #BA-450 or equal.
 2. 2-piece stainless steel body, 300 psi maximum operating pressure, ASTM A-312 compliant, Vic-Press Schedule 10S ends for Type 304 stainless steel pipe, brass body, chrome plated brass ball, brass stem, PTFE seats, steel handle, full port. Manufacturers: Victaulic #Series 589 or equal.

B. Butterfly Valves, 2-1/2" and Larger:

1. 2-1/2" through 12", lug type, MSS SP-67 compliant, 200 psig non-shock, cast or ductile iron body, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Disc may be stainless steel, bronze, nickel-plated ductile iron or aluminum bronze. Mount stem in horizontal position. Molded in seat acceptable in this size range. Manufacturers: Milwaukee #ML223E (up to 5"), Milwaukee #ML323E (6" and larger), Keystone (Emerson) #222 or equal.

2. 14" through 48", lug type, MSS SP-67 compliant, 150 psig non-shock, ductile iron body, stainless steel stem, EPDM seat, memory stop control, worm gear operator. Disc may be stainless steel, bronze, nickel-plated ductile iron or aluminum bronze. Mount stem in horizontal position. Manufacturers: Milwaukee #ML333E, Keystone #GRL, or equal.
3. 2-1/2" through 12" grooved end type, MSS SP-67 compliant, 300 psig working pressure, ASTM A395 and A536 compliant, ductile iron body, EPDM seal, stainless steel stem, and memory stop control. Lever handle thru 5" size and worm gear operator for 6" and larger. Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Manufacturers: Victaulic #Series 761 Vic@-300 MasterSeal, Tyco-Grinnell #B302, Gruvlok #FIG 7700 Series, or equal.
4. 14" through 24" grooved end type, MSS SP-67 compliant, 300 psig working pressure, ASTM A395 and A536 compliant, ductile iron body, EPDM seal, stainless steel stem, with gear operator. Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Manufacturers: Victaulic #Series 761 Vic@-300 AGS (300 psi maximum pressure.), Tyco-Grinnell # FIG 7700 series, or equal.
5. 2-1/2" through 6" copper tube dimensioned grooved end type, cast brass body, EPDM seal, 300 psig working pressure, stainless steel stem, memory stop control, lever handle thru 5" size and worm gear operator for 6". Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Manufacturers: Victaulic #Series 608N, Tyco-Grinnell #B680, Gruvlok #BFV, or equal.

C. Check Valves:

1. Bronze Silent Check Valves – Up to 2" for mounting in close proximity to pumps:
 - a. Class 125, MSS SP-80, ASTM B62, ASTM B16, bronze body, threaded ends, bronze or stainless steel spring, PTFE or Buna disk ring, and silent closing. Manufacturers: Milwaukee #548B (Buna)/548T (PTFE) or equal.
2. Bronze T-Pattern Swing Check Valves – Up to 3" for horizontal mounting adjacent to air handling units and fan coils:
 - a. Class 125, MSS SP-80, ASTM B62, ASTM B16, bronze body, threaded ends, horizontal swing. Manufacturers: Milwaukee #509/509T or equal.
3. Globe Style Silent Check Valves – 2-1/2" and Larger:
 - a. Class 125, MSS SP-125, ASTM A126 class B cast iron body, SS seat and plug, stainless steel spring, SS bushing, stainless screw. ANSI B16.1 flange rating to 190 psi up to 12" and 135 psi above 12". Manufacturers: Milwaukee #1800, Cla-Val #Series 581, Apco #Series 600, Metraflex #Series CVO900 or equal.
4. Wafer Style Silent Check Valves – 2" and Larger:
 - a. Class 125, MSS SP-125, ASTM A126 class B cast iron body, stainless steel seat and disc, stainless steel spring, SS bushing, stainless screw. ANSI B16.1 flange rating to 190 psi up to 12" and 135 psi above 12". Manufacturers: Milwaukee #1400 single disk, Milwaukee #8800 dual disk, Prince #Fig. 810, US Valve #Series 09, or equal.
5. Grooved Style Silent Check Valves – 2" to 12":
 - a. ASTM A536 ductile iron body, single stainless steel disc, EPDM disc coating, brass or stainless steel shaft, stainless steel spring, stainless steel plug. Sizes 2" to 3" rated for 365 psi working pressure and sizes 4" to 12" rated for 300 psi working pressure. Manufacturers: Victaulic #Series 716H/716, Anvil-Gruvlok #Series 7800, Tyco-Grinnell #Series 590 or equal.

- b. Venturi style check valve with flow measuring taps across the valve. ASTM A536 ductile iron body, single stainless steel disc, EPDM disc coating, brass or stainless steel shaft, stainless steel spring, stainless steel plug. Sizes 2" to 3" rated for 365 psi working pressure and sizes 4" to 12" rated for 300 psi working pressure. Manufacturers: Victaulic #Series 779 or equal.

D. Drain Valves:

1. Threaded or soldered ends, Class 125, ASSE 1005, bronze body, screw-in bonnet, rising stem, composition disc, 3/4" hose outlet.
2. Threaded or soldered ends, Class 600, bronze body, 2-piece ball valve, 3/4" hose outlet with cap and chain. Manufacturers: Milwaukee #BA-100H/150H or equal.

E. Globe Valves:

1. 2" and Smaller: Class 150, MSS SP-80 and ASTM B62 compliant cast bronze body, bronze union bonnet, PTFE disc, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Manufacturers: Milwaukee #590T or equal for threaded steel pipe. Milwaukee #1590T or equal for soldered copper pipe
2. 2-1/2" and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Manufacturers: Milwaukee #F-2981-M or equal.

2.05 HVAC SERVICE VALVES (MAXIMUM 250 PSIG SYSTEM WORKING PRESSURE)

A. Ball Valves, 2" and smaller:

1. 3-piece carbon steel body, 1000 psig WOG rating up to 300°F, MSS SP-110 compliant, threaded ends, stainless steel ball, stainless steel stem, reinforced PTFE seat, stainless steel lever handle, full port. Manufacturers: Milwaukee #30CSOF02, Keystone #K-ball Figure 120, or equal.
2. 3-piece stainless steel body, 400 psi maximum operating pressure, ASTM A-351 compliant, Vic-Press Schedule 10S ends or grooved for Type 304 stainless steel pipe, stainless steel ball, stainless steel stem, PTFE seats, stainless steel handle, full port. Manufacturers: Victaulic #Series P569 or equal.

B. Butterfly Valves, 2-1/2" through 18":

1. One-piece carbon steel body, wafer or lug type, MSS SP-68 compliant, Class 300 carbon steel body, stainless steel stem, stainless steel disc, RTFE or reinforced PTFE seat, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Mount stem in horizontal position. Manufacturers: Milwaukee #HP3LCS4212 (up to 5"), Milwaukee #HP3LCS4213 (for 6" and larger), Keystone #K-Lok Figure 37, or equal.

C. Check Valves:

1. Bronze Silent Check Valves – Up to 2":
 - a. 250 psi rating, ASTM B-584 cast bronze body, threaded ends, bronze spring, PTFE disk ring, and silent closing. Manufacturers: Milwaukee #548B (Buna)/548T (PTFE), or equal.
2. Globe Style Silent Check Valves – 2-1/2" and Larger:

- a. Class 250, MSS SP-125, ASTM A126 class B cast iron body, ASTM B584 bronze seat and plug, stainless steel spring, bronze bushing, stainless screw. ANSI B16.1 flange rating to 370 psi up to 12" and 280 psi above 12". Manufacturers: Milwaukee #1850, Cla-Val #Series 581, Apco #Series 600, Metraflex #Series CVO900 or equal.
- 3. Wafer Style Silent Check Valves – 2" to 6":
 - a. Class 250, MSS SP-125, ASTM A126 class B cast iron body, ASTM B584 bronze seat and plug, stainless steel spring, bronze bushing, stainless screw. ANSI B16.1 flange rating to 370 psi up to 12" and 280 psi above 12". Manufacturers: Cla-Val #Series 580, Metraflex #Series CVO700, Milwaukee #Series 1400, Hammond #Series IR9253 or equal.

D. Globe Valves:

- 1. 2" and Smaller: Class 200, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze disc, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Manufacturers: Milwaukee #570 or equal for threaded steel pipe.
- 2. 2-1/2" and Larger: Class 250, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Manufacturers: Milwaukee #F-2983-M or equal.

2.06 BALANCING VALVES (MAXIMUM 125 PSIG SYSTEM WORKING PRESSURE)

A. Pressure Independent Water Flow in Variable Flow Systems:

- 1. 1/2" and Larger: Construction and attachment style as required by piping system. Body shall be brass, bronze, steel or ductile iron as required by valve size. Internal working parts and removable flow cartridge shall be stainless steel. Valves shall be factory set and shall automatically limit the flow to specified capacities with 10% +/- accuracy over the entire operating pressure differential. Pressure and temperature ports shall be extended to outside of insulation. The permanent pressure lost added to the pump head shall not exceed three (3) psi.
- 2. Manufacturers: Pro Hydronic Specialties, Griswold, Victaulic, Danfoss, IMI Flow Design AutoFlow, Oventrop, Hays Fluid Controls, Nexus Valve, or equal.

B. Pressure Dependent Water Flow in Constant Flow Systems:

- 1. 1/2" and Larger: Construction and attachment style as required by piping system. Body shall be brass, bronze, steel or ductile iron as required by valve size. Characterized ball valve or Y-type globe valve design with memory stop. Valves shall be field adjustable. Pressure and temperature ports shall be extended to outside of insulation. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream.
- 2. Manufacturers: Pro Hydronic Specialties #CBV, Hays Fluid Controls Venturi (insert/ball valve style), Preso Venturi #B-Plus series, Oventrop Hydrocontrol #R,F, and G, Griswold (Venturi with characterized ball valve only), IMI Flow Design #FlowSet, Wheatley (Y-globe type only), Armstrong, Nibco (Globe style), Tyco-Grinnell, Oventrop, or Victaulic/Tour & Anderson or Gruvlok(Y-globe type only), #Series 786 (soldered), #Series 787 (threaded), #Series 788 (flanged) or #Series 789 (grooved), Nexus Valve, or equal.

2.07 TERMINAL UNIT ASSEMBLIES – COIL KITS

- A. General: As an alternative to built-up valve and connection assemblies for terminal units, a complete kit consisting of valves, strainer, balancing, and flexible hose connection may be provided. Refer to Section 230548 Vibration Isolation for Piping, Ductwork and Equipment specification for additional requirements for flexible hose. Manufacturers: Victaulic #Koil Kit Series 799 or 79V, Pro Hydronic Specialties, Hays Fluid Controls, IMI #Versaflo, or equal.

2.08 BRANCH CIRCUIT DIFFERENTIAL PRESSURE CONTROL VALVES

- A. Self-powered control valves designed to maintain constant differential pressure for branch circuits and consisting of a differential control, single pressure temperature port, and dead end service shutoff. Shall be capable of stabilizing pressure ranges of 1.5 to 8.7 psi in 3/4" to 1" valves, 2.9 to 11.6 psi in 1-1/4" -2" valves, or 51 psi for 2-1/2" through 4" valves.
- B. Bonnet shall be manufactured of copper alloy, O-rings, seat seal, and membrane to be EPDM.
- C. Manufacturers: Tour & Anderson #793/794 used in conjunction with Victaulic/Tour&Anderson balancing valves, or equal.

2.09 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES (COIL CONTROL VALVES)

- A. Modulating control valves shall be pressure independent characterized two-way actuated flow control valves. The flow rate through the valve shall not vary more than + or - 15% due to system pressure fluctuations across the valve in the selected operating range.
- B. Electronic valves at all variable air volume terminals, constant volume terminals, fan powered terminals, and zone reheat coils with valve connections of 1" (18 gpm) or less in size may utilize floating point control. All air handler coils shall utilize proportional control electronic valves.
- C. The rangeability of the valve shall be 90:1 (minimum).
- D. The valve bodies shall be of cast brass and rated for 200 PSI working pressure (minimum). All internal parts shall be stainless steel, teflon, brass, bronze, or polyphenylsufone orifice with an elastomeric diaphragm. The valves shall be serviceable without removing them from the piping system. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.
- E. Balancing valves shall not be required where these control valves are installed. Flow performance curves shall be provided with each valve
- F. The actuator shall modulate the control valve from 0 to 100% design flow. The actuator shall be directly coupled to the valve at the factory.
- G. Pressure/temperature ports (Pete's Plugs) shall be installed at the factory in each valve larger than 1" or be integral to the valve. Two ports shall be used to measure inlet and outlet pressure to the valve.
- H. Manufacturers: Honeywell #VRN, Belimo #PICCV, Hays #Fluid Controls, Victaulic #TCP Series, Danfoss #AB-QM, Griswold #PIC-V/MVP/PIM models, Oventrop #Cocon Q, Flow Control Industries #Delta P Valve, or equal. Valves shall be provided by controls provider and installed by piping.

2.10 HYDRONIC SYSTEM PRESSURE REDUCING VALVES

- A. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tappings and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and fall-off at inlet and outlet pressure indicated.
 - 1. 25-75 psig range. Manufacturers: Watts #LFU5B-Z3, Zurn #600XL or equal.
 - 2. For applications where reducing valve is used in hot water systems provide with asbestos-free insulating cover, with silicone treated fiberglass cover, 1" insulation, and Velcro fasteners. Suitable for temperatures up to 550°F. Manufacturers: Spence #Series E or equal.

2.11 HYDRONIC SYSTEM PRESSURE RELIEF VALVES

- A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Manufacturers: Watts #740 Series or equal.
- B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting (or pressure setting as indicated on construction documents), and so stamped. Size as required. Manufacturers: Watts #100XL, 40XL, 140, N240, or 340 Series, or equal.

2.12 HYDRONIC SYSTEM REDUCED PRESSURE BACKFLOW PREVENTION VALVES

- A. General: All backflow prevention valves shall be State approved. Coordinate with plumbing system for provision of domestic water to reduced pressure backflow prevention to protect domestic water system from connection to hydronic piping systems.
- B. Reduced Pressure Backflow Preventer
 - 1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Manufacturers: Watts #909-QT-S-HW valve with #909AG air gap fitting, or equal.
 - 2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Manufacturers: Watts #909-S-OSY valve with #909AG air gap fitting, or equal.

2.13 THERMOMETERS AND GAUGES

- A. General:
 - 1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
 - 2. No mercury shall be used in thermometers due to hazardous material classification.
 - 3. Manufacturers: Weklser, Ashcroft, Winters, Terice, Marshalltown, Wika, US Gauge, or equal.
- B. Thermometers:

1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
 - a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
 - b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
 - c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
 - d. Stem: Stainless steel, adjustable angle socket, length to suit installation.
 2. Glass Thermometer: Provide adjustable angle 9" thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
 - a. Case: Aluminum or Valox.
 - b. Temperature Sensitive Gage Liquid: Organic non-toxic. No mercury permitted.
 - c. Scale: Aluminum painted white with black markings.
 - d. Connection: 1/2" NPT with thermowell, 1-1/4" UNF swivel nut without thermowell.
 3. Photovoltaic Cell Powered LCD Thermometer
 - a. Case: ABS Plastic.
 - b. Accuracy: 1% of full scale.
 - c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
 - d. Connection: 3/4" NPT with thermowell 1-1/4" UNF swivel nut without thermowell.
 4. Range: Conform to the following:
 - a. Cold Water: -40°F - 160°F with 2°F scale divisions.
- C. Sensor Test Wells:
1. Provide control device test wells as indicated and as required by the BAS. Constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 3" extension for insulated piping. Provide shutoff valves to isolate sensor for maintenance and removal.
- D. Thermometer Test Wells:
1. Provide 1/4" thermometer test wells as indicated and as required by the BAS. Constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 3" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- E. Temperature/Pressure Gauge Connector Test Plugs (Pete's Plugs):
1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200° F (93° C). Construct of brass or stainless steel, equip with 1/2" NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.
- F. Pressure Gauges:

1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
4. Connector: Brass with 1/4" male NPT.
5. Scale: White coated aluminum, with permanently etched markings.
6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

G. Pressure Gauge Cocks:

1. General: Provide pressure gauge cocks/valves between pressure gauges and gauge tees on piping systems. Two-piece bronze body ball valve with threaded ends. Manufacturers: Milwaukee #BA-100 or equal.
2. Snubber: 1/4" brass or stainless steel bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating. Manufacturers: Wika #910.12, Ashcroft #1112, or equal.

2.14 PIPING SPECIALTIES

A. General:

1. Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Strainers - Low Pressure Y-Type Pipeline Style:

1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 150% (minimum) of the working pressure of piping system.
2. Threaded Ends, 2" and Smaller: Cast-iron body, conforming to ASTM A126, screwed screen retainer with centered blowdown fitted with hose bibb. Manufacturers: Spirax Sarco, Keckley, Wheatley, Mueller, or equal.
3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, conforming to ASTM A126, bolted screen retainer with off-center blowdown fitted with 3/4" drain valve. Manufacturers: Spirax Sarco, Metraflex #LPD, Keckley, Wheatley, Mueller, or equal.
4. Grooved Ends, 2-1/2" and Larger: Ductile iron body, conforming to ASTM A395 and ASTM A536, bolted screen strainer with off center blowdown fitted with 3/4" drain valve. Manufacturers: Victaulic #Style 730/731/732, Tyco-Grinnell #Fig. S853 and S55, Gruvlok #FIG 7260/758G, or equal.
5. Strainer screen or basket, Type 304 stainless steel or better.
 - a. Start-up screen for first month of operation shall be a 40 mesh with 0.016" openings and 41% open area. For applications with piping connected to existing piping systems the start-up screen shall be 60 mesh with 0.010" openings and 38% open area.

- b. Start-up screen shall be removed and replaced with normal operation screen after one month of pump operation, or as directed by the water treatment company, and prior to final water balance.
- c. Normal operation screens or baskets, shall be installed prior to final water balance.
 - 1) Strainer sizes up to 2" shall be provided with 20 mesh screens, with 0.035" openings and 49% open area (minimum).
 - 2) Strainer sizes 2-1/2" and larger shall be provided with perforated baskets with 3/64" diameter perforations with 36% open area (minimum).

C. Unions:

- 1. Unions shall be of type specified in following schedule:
 - a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
 - b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
 - c. Stainless Steel, 2" and smaller: 300 psi maximum operating pressure, threaded union, with Vic Press 304™ ends.
 - d. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
 - e. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
 - f. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
 - g. Where grooved joint piping systems are utilized, unions are not required. Grooved joint couplings shall serve as unions.
 - h. Manufacturers: EPCO, Mueller, Stanley G. Flagg, Victaulic, Tyco-Grinnell, Watts, or equal.
- 2. Dielectric Unions:
 - a. Provide standard products recommended by manufacturer for use in service indicated to effectively isolate ferrous (galvanized steel, black steel, zine coated steel) from non-ferrous piping to prevent galvanic action and related corrosion.
 - b. Manufacturers: Watts #LF3000 Series, Zurn #DUX Series, or equal.

D. Dielectric Waterways:

- 1. To effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
- 2. Steel to copper, with thermoplastic dielectric lining.
- 3. 250 psig rated pressure at 210°F.
- 4. Connection: screwed, grooved, sweat, or flanged to match pipe.
- 5. Manufacturers: Victaulic #Style 647, Gruvlok #FIG 7088/7089/7090 or equal.

E. Dielectric Flanges: Provide dielectric flanges and dielectric bolt sleeves for flanged transitions between dissimilar metal piping. Manufacturers: Watts Series 3100 or approved equal.

F. Flanges:

1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
3. Type of pipe and corresponding flanges as follows:
 - a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
 - b. Stainless Steel Pipe, Class 150 stainless steel flange adapter with carbon steel back-up flange and Vic Press 304™ end.
 - c. Welded Steel Pipe, 150 lb. black forged steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.
 - d. Grooved Steel Pipe, Class 150, ASTM A395 and A536 ductile iron flange adapter, with pressure responsive synthetic rubber gasket. Manufacturers: Victaulic #Style 741, Tyco-Grinnell #Fig. 71, Gruvlok #FIG 7401, or equal.

G. Flange Gaskets:

1. Type: full faced or flat ring to suit flange facings.
2. Shall conform to ASTM F-104
3. Minimum thickness: 1/16"
4. Manufacturers: Garlock style 3200 or equal.

H. Pipe Sleeves:

1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum 1/2-inch annular clearance around pipe.
3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20-gauge; 4" to 6", 16-gauge; over 6", 14-gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors. Floor sleeves to extend a minimum of 1" above finished floor. Telescopic, submerged, or adjustable sleeves. Manufacturers: Adjust-to-Crete, AMI, Shamrock, or equal.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.
9. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.

- a. Outer Sleeves: EPDM or NBR attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
 - b. Water Stop Mid-Body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve
 - c. Manufacturers: Hubbard Enterprises/HOLDRITE, Hydro Preseal, or equal.
- I. Sleeve Seals:
1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
 2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
 3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
 4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.
- J. Watertight Sleeve-Seal Systems:
1. Wood Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
 - a. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
 - b. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
 - c. Retain subparagraph below if fire resistance rating is required.
 - d. Provide a one-hour, two-hour, or three-hour fire-resistance rated assembly as required at penetration when tested according to ASTM E 814 or ANSI/UL 1479.
 - e. Manufacturers: Hubbard Enterprises/HOLDRITE, Hydroflame Sleeve, or equal.
 2. Metal Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.
 - a. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
 - b. Includes a cone attached to the base for extending the device through the metal deck and a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
 - c. Provide a one-hour, two-hour, or three-hour fire-resistance rated assembly as required at penetration when tested according to ASTM E 814 or ANSI/UL 1479.
 - d. Manufacturers: Hubbard Enterprises/HOLDRITE, Hydroflame CMD Metal Deck Device, or equal.

K. Pipe Escutcheons:

1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors and walls, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

L. Drip Pans:

1. Provide drip pans fabricated from 20-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection.

2.15 EXPANSION COMPENSATORS AND FLEXIBLE PIPING CONNECTIONS

- A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ANSI B31.1 for pressure piping. Vertical piping for chilled water, heating water, and condenser water shall be provided with system flexibility to allow expansion compensation at each floor level without inducing stresses on branch piping. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.
- B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows, hose, braid, shroud and flange end fittings. Manufacturers: Keflex #311 series, Metraflex #GIL04F series, or equal.
- C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Manufacturers: Metraflex #Metraloop, Unisource #V-SF21 Style, Mason Industries #VEE Assembly, or equal.
- D. Flexible Connection for Steel Pipe (piping and equipment located outside the building): Stainless steel hose and braid, with threaded, grooved or flanged ends. Provide steel supports to prevent sagging as required. Manufacturers: Metraflex #SST, Mason Mercer, or equal.
- E. Three grooved joint flexible type, not rigid, couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Manufacturers: Victaulic #Style 177 or 77, Tyco Grinnell #Fig. 705 and 707 couplings, or Gruvlok #FIG 7401.
- F. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Provide steel supports to prevent sagging is required. Manufacturers: Metraflex #BBS, Unisource #V-BF11 Style, Mason Industries or approved equal.

- G. Flexible Rubber Connectors (Pump Connections): Concentric spool type expansion joint, single or double arch. Chlorobutyl tube and cover, meeting ASTM specification D2000 Grade 2AA610AB, L13. The body shall be reinforced with rectangular body rings and a minimum of six bias plies of polyester fabric. A hypolon coating shall be applied completely and uniformly to the cover. All expansion joints shall be rated 190 psi/26-inch vacuum at 250° F for sizes up to and including 12 inches.
1. For chilled water, condenser water, and non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26-inch vacuum at 250° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturers: Garlock #206 EZ-FLO or equal.
 2. Three grooved joint flexible type couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Manufacturers: Victaulic #Style 177 or 77 or Gruvlok #FIG 7401.
- H. Expansion Joints for Grooved Piping: For piping systems fabricated from grooved pipe and couplings, use one of the following methods for expansion compensation:
1. Combination Couplings and Nipples: Provide expansion joints constructed of grooved short pipe nipples and flexible couplings, designed by manufacturer to suit intended service. Provide removable ties to hold joint compressed or expanded during piping fabrication, depending on application. Total joint end movement is dependent on the number of couplings/nipples in the joint. Select couplings and gasket materials to match balance of piping system. Manufacturers: Victaulic #Series 155 or Gruvlok #FIG 7240.
 2. Slip-Type Expansion Joints: Provide slip-type expansion joints constructed of carbon steel pipe and couplings, designed by manufacturer to suit intended service. Joint shall be gasketed expansion joint, with grooved ends. Slide section coated with PTFE modified PPS (Polyphenylene Sulfide) coating. Joint suitable for axial end movement up to 3". Select couplings and gasket material to match balance of piping system. Manufacturer: Victaulic #Style 150 or equal.
 3. Three flexible couplings: Use three flexible couplings for the first three connections in close proximity to a pump or chiller to eliminate flexible rubber connectors. Manufacturers: Victaulic #177, 75 or 77, Tyco-Grinnell #Fig. 705 and 707, or Gruvlok #FIG 7401.
- I. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Manufacturers: Metraflex #Style IV or equal.
- J. Expansion Loops: Provide field fabricated pipe expansion loops as an alternate to mechanical expansion joints. Expansion loops in IPS steel and roll grooved copper tubing systems shall be accommodated with loops or bends consisting of eight (8) mechanical groove-type couplings, four (4) 90-degree elbows, and three (3) grooved end pipe spools provided in water systems up to 250°F in accordance with recommendations for expansion compensation.
- 2.16 EXPANSION TANKS
- A. Bladder Type Pre-Pressurized:

1. The pressurization system shall include a bladder-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate entrained air. The system's expanded water shall be contained in the acceptance volume heavy-duty butyl bladder. Maximum acceptance volume for any tank shall not exceed 65% of the tank volume for purposes of tank selection. Bladder shall be removable and replaceable.
2. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII Division 1 of the ASME Boiler and Pressure Vessel Code for working pressures to 300 psi, maximum operating design temperature of 240°F, and pre-charged to the 12 psi (minimum). Adjust pressure charge after installation based on system requirements.
3. The tank shall have a minimum 3/4" NPT system water connection and a 0.302"-32 air charging valve connection (standard tire valve) to facilitate on-site charging by system installer to meet system operating requirements.
4. Provide integrity monitor or sight glass to allow for maintenance observations.
5. Provide with base mounting clips for attachment to floor or pad.
 6. Manufacturers: Amtrol #L Series, Wessels #NLA Series, Taco #CA Series, Bell and Gossett #B Series or equal.

2.17 AIR ELIMINATION

A. Manual Air Vent

1. To be located at the high points in all closed and open hydronic piping systems for manual air venting, including high points at coil connections, and where shown on the drawings.
2. Body: Bronze or brass.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew. Knurled thumbwheel with blowout-proof actuating stem.
5. Inlet Connection: Minimum 1/4" NPT. Extended stem, minimum 2" long, to terminate above insulation/jacket surface.
6. Maximum operating pressure: 250 psig.
7. Maximum operating temperature: 300°F.
8. Manufacturers: Nexus #MV-025L or equal.

B. Automatic Air Vent – Low Capacity Pipe Connections

1. For automatic air venting at all high points in all closed and open hydronic piping systems to be located at the top floor of each pipe riser (supply and return), other high points in piping where air binding may occur, and other locations shown on drawing and as required for complete air venting of piping system. Air vents shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
2. Body: Bronze, brass, steel or cast iron.
3. Float: Stainless steel.
4. Seat: Stainless steel or brass.

5. Inlet Connection: Minimum 1/4" NPT. Extended stem, minimum 2" long, to terminate above insulation/jacket surface.
 6. Outlet Connection: Minimum 1/4" discharge pipe routed to nearest floor drain or floor sink or other approved drainage location.
 7. Maximum operating pressure: 150 psig.
 8. Maximum operating temperature: 250°F.
 9. Manufacturers: Hoffman (Xylem) #78, Nexus #AV-025, or equal.
- C. Automatic Air Vent – High Capacity Equipment Connections
1. For high capacity air venting in all closed hydronic piping systems to be located on the top of air separators, boilers, chillers, pump skid high points, heat exchangers and other locations shown on drawing and as required for complete air venting of piping system. Air vents shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
 2. Body: Bronze, brass, steel or cast iron.
 3. Float: Stainless steel.
 4. Seat: Stainless steel or brass.
 5. Inlet Connection: Minimum 1/2" NPT. Extended stem, minimum 2" long, to terminate above insulation/jacket surface.
 6. Outlet Connection: Minimum 3/8" with discharge pipe routed to nearest floor drain or floor sink or other approved drainage location.
 7. Maximum operating pressure: 150 psig.
 8. Maximum operating temperature: 250°F.
 9. Manufacturers: Metraflex #MVC-15, Spirotherm #Spirotop, Hoffman (Xylem) #792 or #107A, Amtrol #747, or equal.
- D. Air and Dirt Separators - Tangential and Coalescing Media Type
1. All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all system points as indicated on the drawings.
 2. The air separator shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi.
 3. Air separators shall be sized as indicated on Drawings.
 4. Provide with strainer unless otherwise noted.
 5. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM.
 6. Units shall eliminate 99.6% of system air (including entrained air and microbubbles). Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units may include internal copper coalescing medium to facilitate maximum air elimination and suppress turbulence or be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose.
 7. Provide integral high capacity float actuated air vent at top fitting of tank or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the separator. Unit shall have bottom blow down connection.

8. Manufacturers: Amtrol #ADS Series, Spirovent, Xylem Bell & Gossett, TACO, Patterson, Wheatley, Armstrong, Spirovent or equal.

2.18 CHEMICAL POT (BYPASS) FEEDER

- A. Provide a pot (bypass) feeder with removable cover, bottom drain valve, and shut-off valves. Provide balancing valve and check valves as shown on Drawings.
- B. The size of the pot feeder is to be five (5) gallons for piping systems under 15,000 gallons (total) and 10-12 gallons for systems over 15,000 gallons. The feeder is to have the ability to have a removable top without tools needed, inlet port, outlet port, drain port and meet pressure rating requirements of the system.
- C. Steel body, rated at 125 psig and 250°F. Tank shall have 3-1/2 inch (minimum) neck opening.
- D. Mount on support stand, with integral legs, or attached to the wall and pipe between the supply and return piping as shown on Drawings. Provide clearance under the pot feeder for gravity draining to approved sanitary sewer location.
- E. Manufacturers: Dearborn, Garrett-Callahan, J.L Wingert, Neptune, or equal.

2.19 HYDRONIC WATER BUFFER TANK

- A. Provide vertical buffer tank with features indicated herein and per the drawings. If chilled water system total volume is less than 6 gallons per ton of capacity (10 gallons for low temperature/ice storage systems) or less than a 3 minute total system changeover flow, install a buffer tank sized as needed to achieve the minimum total system water volume.
- B. Fabricate base, frame, and attachment to tank components strong enough to resist tank movement during a seismic event when tank base is anchored to concrete base slab.
- C. The buffer tank shall be welded carbon steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a maximum working pressure of 125 psig/200 psig/250 psig as required.
- D. The tank shall be epoxy lined to extend service life.
- E. Tank connections shall include:
1. 3/4" NPT top air vent connection with automatic air vent and drain line routed to approved receptacle.
 2. 1" NPT bottom drain outlet connection with hose bibb valve.
 3. Flanged or grooved chilled water inlet and outlet sized to match system piping.
- F. Manufacturer: Wessels #CBT Series, A.O. Smith, Hanson Tank, or equal.

2.20 SUPPORTS AND ANCHORS (SEE SECTIONS 23 05 00 AND 23 05 49)

2.21 WATER TREATMENT SYSTEMS (SEE SECTION 23 25 00)

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
- B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal or otherwise irregular work unless so indicated on Drawings or approved by the Owner's Representative.
- C. Coordinate mounting and attachment of piping and tanks with Structural Engineering design.
- D. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Owner's Representative.
- E. The cooperative work not included in the Mechanical Division related to the general construction work is as follows:
 - 1. All formed concrete work
 - 2. Framed openings in masonry and other Architectural and Structural elements
 - 3. Wood grounds and nailing strips in masonry and concrete
- F. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and waterproof material cover to protect equipment and piping delivered to and stored at the site.

3.02 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturer's directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications. Provide additional valves, strainers, unions, etc. as required by manufacturer installation instructions.

3.03 WORKING PRESSURES

- A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.
- B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

3.04 PIPE SIZES TO EQUIPMENT

- A. General: Pipe sizes indicated on drawings shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.
- B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.05 PIPING INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.
- C. Install expansion joints, expansion loops, expansion bends, and similar units to accommodate project seismic movement across building expansion joints and in vertical risers to accommodate drift between vertical buildings levels.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Check Valves: All check valves should be installed in a location that has smooth and laminar flow conditions. Use the following general rules for check valve installations:
1. Downstream of a reciprocating pump or other turbulence inducing device (elbow, tee, etc.)
 - a. Swing Type: Locate valve a minimum of 10-12 diameters downstream of the device.
 - b. Silent Type: Locate valve a minimum of 4-5 diameters downstream of the device.
 2. Pipe fittings, elbows, reductions, etc. downstream of the valve:
 - a. Swing Type: Locate elbow a minimum of 5-7 diameters downstream of the valve.
 - b. Silent Type: Locate elbow a minimum of 2-3 diameters downstream of the valve.

J. Strainers

1. Install strainers in piping and locate upstream of control valves, coils, and heat exchangers where shown on drawings and as required by equipment and controls manufacturers.
2. Strainer screen or basket shall be Type 304 or 316 stainless steel.
 - a. Start-up screen for first month of operation shall be a 40 mesh with 0.016" openings and 41% open area. For applications with piping connected to existing piping systems the start-up screen shall be 60 mesh with 0.010" openings and 38% open area.
 - b. Start-up screen shall be removed and replaced with normal operation screen after one month of pump operation, or as directed by the water treatment company, and prior to final water balance.
 - c. Normal operation filter screens or baskets shall be installed prior to final water balance.
 - 1) Strainer sizes up to 2" shall be provided with 20 mesh screens, with 0.035" openings and 49% open area (minimum).
 - 2) Strainer sizes 2-1/2" and larger shall be provided with perforated baskets with 3/64" diameter perforations with 36% open area (minimum).

K. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

L. Cleaning: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings (if any).

3.06 SLOPING, AIR VENTING, AND DRAINING

- A. Provide hose bibb valve, with threaded brass cap, at all low points in piping for maintenance drainage. Provide drains on each side of air handling coils and heat transfer devices. Provide drains at each low point in the piping on each floor level.
- B. Connect all branch piping to the bottom or side of their respective hydronic mains. Where connections must be made to the top of the main piping, make provision for venting of air.
- C. Provide drain discharge pipe from each temperature relief valve and/or pressure relief valve as required by mechanical code. Discharge pipes shall and discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards, or indirectly terminated above an approved location such as a floor sink or floor drain.
- D. Provide manual or automatic vents at all high points in water piping, at high points in the piping and adjacent to each coil, and where shown on the drawings.
 1. Manual air vents shall be located at the high points in all closed and open hydronic piping systems for manual air venting, including high points at coil connections, and where shown on the drawings. Provide at high points in piping system on each floor.

2. Automatic air vents shall be provided in all closed hydronic piping systems and located on the top of air separators, boilers, chillers, pump skid high points, heat exchangers and other locations shown on drawing and as required for complete air venting of piping system. Air vents shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations. Route drain pipe to nearest floor drain or floor sink or other approved drainage location.

3.07 PIPING SYSTEM JOINTS

- A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.
- B. Provide joints of type indicated in each piping system.
- C. Piping shall be capped during construction to prevent entry of foreign material.
- D. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- E. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.
 1. Manufacturers:
 - a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
 - b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".
 - F. Mechanically Formed Extruded Tee Fittings: Form tee in copper tube according to ASTM F2014. Forming procedures shall be in accordance with the tool manufacturer's recommendations. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar. Formed tee fitting shall not be greater than 50% of the diameter of the main run tube/pipe. Soldered joints are not allowed.
 1. Mechanically formed extruded outlets shall be perpendicular to the axis of the run tube (main pipe). Holes shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch wall.
 2. Branch tubes shall not restrict the flow in the run tube. A dimple (depth stop) shall be formed in the branch tube to ensure that penetration into the collar is of the correct depth. For inspection purposes, a second dimple shall be placed 0.25 inch above the first dimple. Dimples shall be aligned with the tube run.
 3. Manufacturer: T-Drill or equal.

- G. Braze copper tube and fitting socket or mechanically formed tee fittings with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.
1. Brazing fittings may use a mechanically limited depth that is not less than the minimum cup depth (overlap) specified by ANSI/ASME B16.50 for Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings. Manufacturer of mechanical dimpler: Brazing Dimpler Corp or equal.
- H. Depth of solder joint and braze joint fitting:

Depth of Solder Joint and Braze Joint Fittings		
Pipe Size (inches)	ASME 16.22 Solder Joint Socket Depth (inches)	ASME B16.50 Brazed Joint Socket Depth (inches)
1/2	0.50	0.22
3/4	0.62	0.25
1	0.75	0.28
1-1/4	0.97	0.31
1-1/2	1.09	0.34
2	1.34	0.40
2-1/2	1.47	0.47
3	1.66	0.53
4	2.16	0.64
5	2.66	0.73
6	3.09	0.83
8	4.09	1.28

- I. Weld pipe joints in accordance with recognized industry practice and as follows:

1. Weld pipe joints only when ambient temperature is above 0°F.
 2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
 3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
 5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
 6. With engineering pre-approval stub-in saddle taps may be acceptable for aboveground branch connections, in non-critical areas, where the branch size is less than 50% of the main size and where branch sizes are 3", or smaller, in diameter. Pipe main must be larger than 8" diameter in a renovation project for consideration.
- J. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- K. Grooved Joints:
1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall meet AWWA C-606 requirements.
 2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
 3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
 4. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.
- L. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing such as copper to zinc plated equipment fittings or copper to galvanized steel or black steel equipment:
 - a. Dielectric Fittings for NPS 2" (DN 50)] and Smaller: Use dielectric couplings, nipples, unions.
 - b. Dielectric Fittings for NPS 2-1/2" to NPS 4" (DN 65 to DN 100): Use dielectric flange kits or threaded nipples.
 - c. Dielectric Fittings for NPS 5" (DN 125) and Larger: Use dielectric flange kits.
 2. Dielectric couplings are not required in the following locations:
 - a. Unions in a copper piping system with connections to brass/bronze valves and devices.

- b. Unions in a copper piping system with connections to stainless steel valves and devices.
- M. Adhesive Bonded Joints: All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained and certified to the bonding procedure specification provided by the pipe manufacturer. This specification shall meet or exceed the requirements of ASME B31.3, Section A328.2.1. The pipe manufacturer or their authorized representative shall train the contractor's employees in the proper joining and assembly procedures required for the project including hand-on participation by the contractor's employees in accordance with the manufacturer's specification.
- N. Vic-Press 304™ Joints: Pipe shall be certified for use with the Vic Press 304™ system. Pipe shall be square cut, +/- 0.030", properly deburred and cleaned. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly. Use a Victaulic 'PFT' series tool with the proper sized jaw for pressing.

3.08 VALVES

- A. General: Except as otherwise indicated, comply with the following requirements.
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping, strainers and other equipment. Locate valves so as to be accessible and so that separate support can be provided as necessary.
 2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
 3. Install butterfly valves with stems mounted horizontally.
 4. All valves mounted higher than 10 feet above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 5 feet above floor.
- B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.
- C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
1. Copper Pipe, 2-1/2" and Smaller:
 - a. Soldered-joint valves.
 - b. Grooved-joint valves.
 2. Copper Pipe, 2-1/2" and Larger: Grooved-joint valves.
 3. Stainless Steel Pipe, 2" and Smaller: Vic Press 304™ joint valves.
 4. Steel Pipe, 2" and Smaller: Threaded joint valves.
 5. Steel Pipe, sizes 2-1/2" and larger: One of the following, at installer's option:
 - a. Flanged valves.
 - b. Lug valves.
 - c. Grooved-end valves.

- D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
- E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.
- F. Fluid Control: Except as otherwise indicated, install gate, globe, ball, plug, circuit setter, glove, and butterfly valves to comply with ASME B31.9.
- G. Check Valves: Install in vertical or horizontal a minimum of three (3) pipe diameters downstream of pump outlet.
- H. Wafer Style Silent Check Valve: Install between two (2) flanges and use full size bolts to assure center alignment.
- I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception
- J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.
- K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.
- L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.
- M. Install so handles are readily available. Locate valves and valve handles for appropriate maintenance access.
- N. Gasket and O Ring Material: Valve manufacturer is responsible for submittals. Provide gasket and O ring material best suited for the both piping systems.

3.09 TEMPERATURE GAUGES AND THERMOMETERS

- A. General: Install temperature gauges/thermometers in vertical upright position and tilted so as to be easily read by observer standing on floor without supplemental illumination.
- B. Install in the following locations and elsewhere as indicated:
 - 1. At inlet and outlet of chillers.
 - 2. At inlet and outlet of fluid coolers.
 - 3. At inlet and outlet of heat exchangers.
 - 4. At inlet and outlets of boilers.

3.10 PRESSURE GAUGES

- A. General: Install pressure gauges in vertical upright position and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gauges to be installed with snubbers to absorb system shock.
- B. Install in the following locations and elsewhere as indicated:
 - 1. At inlet and outlet of pumps.

2. At inlet and outlet of chillers.
3. At inlet and outlet of heat exchangers.
4. At inlet and outlet of boilers.

3.11 IDENTIFICATION MARKERS (SEE SECTION 23 05 00)

3.12 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1" minimum annular clear space between piping/insulated piping and concrete slabs and walls.
 1. Retain subparagraph below when cast-in-place watertight sleeve seals are required.
 2. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.
 3. Retain subparagraph below if applicable.
 4. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2" above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4" (6.4 mm) annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
 4. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping." Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.13 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thicken;
- D. ss of wall.
 - 1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
 - 2. Position cast-in-place water tight sleeve in wall space securing sleeve to reinforcing steel using tie wire.
- E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples.

3.14 EXPANSION COMPENSATION

- A. Expansion Loops/Connectors at Expansion Joints:
 - 1. Provide flexible hose expansion loop(s) or connectors as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction, building settlement, or seismic movement of the piping system.
 - 2. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
 - 3. Flexible loops shall be capable of movement in the $\pm X$, $\pm Y$, and $\pm Z$ planes to meet or exceed the limits identified in the structural design.
 - 4. Flexible hose expansion loops and connectors shall impart no thrust loads to system support, anchors or building structure.
 - 5. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.
 - 6. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.
- B. Expansion Compensation for Risers and Terminals:
 - 1. Install connection between horizontal piping mains and vertical piping risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.
- C. Thermal Expansion Compensation:
 - 1. Provide piping U-Bend, Z-Bend, L-Bend or flexible devices to accommodate thermal expansion and contraction in piping system where shown on drawings and as required to impart minimal stress in piping and building structure.

3.15 PIPE INSPECTIONS

- A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. "Rough-in" "Top-out" and final.
- B. Inspection - Belowground: All piping installed underground shall be inspected prior to burial by the Owner's Representative. Provide photographs of underground piping in Operation and Maintenance Manuals including location and depth of pipes. Contractor must notify the Owner's Representative no less than 24 working hours prior to inspection time. Should the piping be buried without approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.
- C. Inspection - Aboveground: All piping installed aboveground shall be inspected upon completion and prior to finish of walls and ceilings by the Owner's Representative. Contractor must notify the Owner's Representative no less than 24 working hours prior to inspection time. Should the piping be hidden within the structure prior to inspection approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.16 TESTING

- A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Testing shall be witnessed by an independent third party inspector. Upon completion of testing, certify to the Owner's Representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by third party inspector.
- B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The systems may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.
 - C. Test time for final pressure test and report will be accrued only while full test pressure is on the entire piping system. Pressure tests shall be witnessed by the Owner's Representative. Provide minimum 48-hour notice prior to start to each test. "Tolerance" shall be no perceptible pressure drop, except that due to temperature change in a 24-hour test period (minimum). Inspect and test all work prior to burying or concealing. Test pressure shall be 100 psig or 1.5 times the system operating pressure, whichever is greater. If approved by the local Authority Having Jurisdiction, the maximum test pressure may be limited to 50 psi greater than the operating pressure, but in no case less than 100 psig. Final test medium shall be water and pressure shall be applied and measured at the lowest floor level of the piping system. Confirm maximum pressure testing requirements with pipe manufacturer and do not exceed the maximum pressure rating of the piping.
- D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.
- E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, and air vents for proper performance. Test all air vent points to ensure that all air has been vented.

3.17 WATER TREATMENT EQUIPMENT AND SYSTEMS

- A. Install water treatment equipment and provide water treatment for systems as designated in Section 23 25 00 HVAC Water Treatment and other Division 23 sections.
- B. Close, fill system and provide chemical treatment as soon as possible after final flushing to minimize corrosion.

3.18 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Clean systems with chemicals specified in Section 23 25 00 HVAC Water Treatment. Follow the method provided below or a method recommended by the suppliers of the chemicals specified in Section 23 25 00.
 - 1. General Initial flushing:
 - a. Remove loose dirt, mill scale, metal chips, weld beads, rust, and similar deleterious substances without damage to any system component.
 - b. Provide temporary piping or hoses to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place.
 - c. Isolate or protect clean system components, including pumps and pressure vessels, and remove any components which may be damaged.
 - d. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris-carrying velocity of 3 to 6 feet per second, if possible.
 - e. Connect dead-end supply and return headers as necessary. Flush bottoms of risers.
 - f. Install temporary strainers where necessary to protect down-stream equipment.
 - g. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and contractor's booster pumps.
 - h. Flush until clean as approved by the Owner's Representative.
 - 2. Closed Circulating Water Systems:
 - a. Fill system with local utility water; start circulation pump and vent high points manually until all air is released from the system.
 - b. Flush the system with fresh water, drain a second time and refill. After final filling, the pH of the water must not exceed the pH of the fresh incoming water by more than 0.5 pH.
 - c. Introduce the chemical cleaning solution into the system gradually by injecting into the suction side of the circulating pump, or by means of a pot (bypass) chemical feeder. If it is a chilled water system, do not turn on the compressor. If it is a glycol system, use softened makeup water.)
 - d. While the water is being circulated, check to make sure that all passages are open and adequate flow velocity is present throughout the system.
 - e. During circulation, open each drain connection for a short flow. Repeat at hourly intervals. Replace water drained during blowdown with chemical solution as required until air is eliminated from the system. The chemical cleanout procedure shall be continuous in this manner for two full 8-hour periods.

- f. Propylene glycol-base industrial coolant shall be added to closed system to prevent freezing of water based systems exposed to sub-freezing conditions. Glycol must be thoroughly mixed before the solution is entered into the system. Provide percentage of glycol as recommended by manufacturer to meet local design conditions. Turn over an additional 20 gallons (minimum) of glycol at completion of construction to Owner. Manufacturers: Dow, Union Carbide or equal.

3. Open Condenser Water Systems:

- a. Fill system completely
 - b. Use an oxidizing disinfectant surfactant cleaner for cooling towers with non-metallic internal coatings. Use chemically neutral cleaner for cooling towers with galvanized coating. Use alkaline low foaming surfactant for stainless steel cooling tower systems.
 - c. For packaged unit systems bypass the systems as necessary with temporary piping. For central chiller plants, protect heat exchangers with 150 mesh screens at heat exchanger inlets.
 - d. Circulate water with high levels of cleaner for 4 to 8 hours.
 - e. Test system pH at 60-minute intervals, pH should be above 10.0 while cleaning is taking place, unless water is flowing through a galvanized tower then pH remains between 7.0-8.0. Add more chemicals, to keep pH level. Have anti-foam on-site to prevent pump cavitation.
 - f. Flush entire system with fresh water to reduce pH within 0.5 pH of incoming water and test system pH, conductivity, alkalinity.
 - g. Clean and flush circulators mud legs and strainers.
 - h. Isolate and drain cooling tower.
 - i. Clean/vacuum tower sump and distribution pan.
 - j. Treat with water treatment chemicals at elevated dosage as necessary.
4. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body using the velocity of this throttling action. Flush for not less than one hour. Fill entire system with clean water and vent all air.

3.19 WATER ANALYSIS AND TREATMENT

- A. Upon completion of systems installation, cleaning, and filling, engage a qualified water treatment firm, acceptable to the Owner's Representative. Treat systems with chemicals and procedures specified in Section 23 25 00 HVAC Water Treatment. The water treatment firm shall perform a chemical analysis on each system listed hereinafter, and shall submit to the Owner's Representative a report, including the following:
 - 1. Analysis of each water system.
 - 2. Initial treatment of each system.
 - 3. Recommendations regarding subsequent, periodic, or continuous treatment on each system.
- B. Contractor is to furnish and install initial treatment.

- C. For all systems the contractor is to provide for periodic testing after startup and shall provide all recommended treatment for first year of building occupancy.

END OF SECTION

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SECTION 23 21 14

HYDRONIC UNDERGROUND PIPING

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. Provide all labor, materials and equipment required to complete the mechanical site utility work of the Contract Documents. Verify all existing utilities and exact locations prior to installation of new piping and provide all necessary trim and fittings for required connections. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing the following:
 - 1. Chilled water piping.
 - 2. Condenser water piping.
 - 3. Heating hot water piping.
 - 4. Piping accessories.
 - 5. Valves and valve boxes.
 - 6. Expansion compensation.
 - 7. Thrust blocks.
 - 8. Excavation, trenching and backfill.
 - 9. Cathodic protection for buried carbon steel piping.
 - 10. Cleaning and testing of piping.
 - 11. Connection of site utility services to building piping system of buildings, to existing site utilities and to site utilities specified under other divisions.
- B. Provide complete design, hardware, installation, maintenance, and repair requirements for the direct bury piping system.
- C. A complete, underground piping system including carrier piping, pipe supports, insulation, air/water-tight outer protective casing, anchors, corrosion protection, casing drain-connections, casing vent connections, and accessories to a point at least 6 inches inside the buildings.
- D. Piping dimensions, as identified on drawings and in specifications, refer to the interior free dimensions. Adjust selected pipe sizes and work as necessary to account for larger outside dimensions to account for material wall thickness.

- E. Performance of each piping systems shall be based on heat transfer calculation for the longest underground path at full design capacity. Heat transfer calculations shall be provided by pipe system manufacturer for each service starting with the point of supply where the pipe enters the underground system to the most remote location where the pipes transitions into a building. Calculations shall be based on fluid flows at full design capacity. Heat transfer calculations for above grade piping are not included in the section. Insulation thickness shall be based on maximum allowable heat transfer. Return water insulation thickness shall match supply water thickness. For each system the maximum allowable temperature rise or drop shall be limited to the following:
1. Chilled water supply: 2°F rise from design based on 70°F ground temperature.
 2. Heating water supply: 2°F drop from design based on 40°F ground temperature.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Coordinate with site work and civil engineering design for trench excavation and backfill, paving and cast-in-place concrete.
- B. Section 23 05 00: Basic HVAC Materials and Methods
- C. Section 23 21 13: Hydronic Piping, Valves and Specialties
- D. Section 23 21 23: Hydronic Pumps
- E. Section 23 07 19: HVAC Piping Insulation
- F. Section 26 42 00: Cathodic Protection

1.04 TRENCHING, BACKFILLING, AND COMPACTION

- A. Provide trenching, backfilling, and compaction for the Work of this Section.
- B. Trenching, backfilling, and compaction shall comply with requirements referenced in Section 23 05 00 and relevant Architectural specifications, in addition to requirements specified in this Section.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of piping system, boxes and accessories.
- B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams
1. Complete descriptions and drawings of design of system and materials of construction including sizes, types, locations, component parts, assembly, carrier pipes, casing, anchors, pipe guides, pipe supports, expansion loops, and building wall and floor penetrations, end seals, leak plates, field installation instructions, design of the transition points to aboveground systems.
 2. Manufacturer's data sheets on coatings, carrier pipe and insulation.
 3. Expansion Bends:
 - a. Locations, sizes, types, movements.
 - b. Anchor locations, design, forces and moments.

4. Calculations approved and stamped by Professional Engineer demonstrating that allowable stress of piping will not be exceeded due to thermal expansion and that anchor forces and moments are not excessive. Calculations shall be performed by a finite-element, three-dimensional analysis computer program.
 5. Calculations and drawings for thrust blocks.
 6. Drawings and calculations shall have professional engineer's stamp.
 7. Heat transfer calculations to validate insulation thickness per system.
 8. Type and details of the cathodic protection system including dielectric gaskets. Design life calculations for cathodic protection system. Coordinate with Div 26.
- C. Maintenance Data: Submit maintenance data and replacement material lists. Include this data in maintenance manual.
- D. Product Samples: Provide one 12" long sample of each proposed type of pipe.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
 - B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components - remove from project site.
- 1.07 QUALITY ASSURANCE
- A. Manufacturer Qualifications:
 1. Manufactured items furnished shall be current and cataloged products of the manufacturer.
 2. Replacement parts, piping and fittings shall be readily available and stocked in the USA.
 3. The piping systems shall conform to specification requirements and shall be manufactured by a company which specializes in these systems, and which has been in the business in excess of five years.
 4. The installation of each direct-buried system shall be performed by a contracting firm with documented experience in excess of five years.
 - B. Manufacturer Engineered Piping Systems: (Note to Editor-Revise as necessary if underground piping system must be engineered to accommodate expansion/contraction, heat lose/gain, thrust blocking, insulation thickness, cathodic protection, etc. Coordinate with site conditions and manufacturer to determine necessary scope of work.)
 1. For all Grade B (ASTM A53 carbon steel piping specified below grade provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.
 2. Manufacturers of assemblies of products, which include components made by others, shall assume complete responsibility for final assembled unit.
 3. Certification that system manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. This certification shall be an original signed by a principal officer of the manufacturer.

4. Manufacturer's quality assurance plan for fabrication, delivery, storage, installation and testing of system. Certificate of Qualification from system manufacturer that his field representative regularly performs the specified duties in relation to monitoring the installation of the system, that he is technically qualified and experienced in the installation of the system and is authorized by the supplier to make and sign the daily reports specified herein.
 5. A proposed schedule of activities indicating when various items of work and tests are to be carried out and when quality control inspectors of the supplier will be present at the job site.
 6. A written report from the manufacturer's representative, at the job site, during critical stages of material delivery and construction.
 7. Upon completion of the work, Certificate of Compliance, signed by the manufacturer and the contractor, certifying that the system has been installed in accordance with contract requirements.
- C. Codes and Standards:
1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
 2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
 3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
 4. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
- D. Product Delivery, Storage and Handling
1. Deliver products to the site in containers with manufacturer's stamp or label affixed.
 2. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
 3. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components - remove from project site.
 4. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
 5. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
 6. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.

7. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
8. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
9. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.
10. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.
11. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
12. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired
13. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.

E. Welding Qualifications:

1. Steel Support Welding: Qualify procedures and personnel according to American Welding Society AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."
 - a. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation per pressure and temperature operating class.
 - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 DIRECT BURIED PIPING

A. Chilled Water Piping

1. Polyvinylchloride (PVC) Schedule 80 Pipe: Pre-insulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Chill-Therm, Perma-Pipe, Rovanco or equal.
 - a. Carrier Pipe and Fittings: All PVC Schedule 80 pipe shall be manufactured in conformance to ASTM D1785 and ASTM D2267. Maintain minimum interior dimension as identified on drawings.
 - b. Fittings and joints joined using solvent weld glue and are manufactured from PVC material which meets or exceeds requirements of ASTM D1785, cell classification 12454B, Type 1, Grade 1. Fittings and couplings shall be field insulated per manufacturer requirements.
 - c. Casing: Polyurethane insulation with jacket and mastic end seals.
 - d. Insulation: Polyurethane foam with K-factor = 0.165 (maximum), density = 2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat gain in distribution system.
 - e. Jacketing Material: Seamless Polyvinylchloride (PVC) meeting the specifications of ASTM D1784 or high density polyethylene (HDPE), conforming to ASTM D1248. Minimum wall thickness of 0.06 inches for the PVC jacketing material and 100 mils for the HDPE jacketing material.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
2. High Density Polyethylene (HDPE): Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor #Polycor HDPE, Perma-Pipe, Rovanco, or equal.
 - a. Carrier pipe: Pipe shall be manufactured from a high density polyethylene (HDPE) conforming to ASTM D3350 and D2837 with SDR wall thickness based on design temperature and pressure requirements ranging up to 255 psi and maximum operating temperature of 140°F. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria. Maintain minimum interior dimension as identified on drawings.
 - b. Fittings and joints using butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing (minimum). Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 100 mils for small pipe diameters.
 - e. Warranty: Minimum 2 years.

- f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
3. Plastic (Polypropylene) Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Rovanco or approved equal.
 - a. Carrier pipe: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. All pipes shall be made in a three-layer extrusion process. Piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipes shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria. Maintain minimum interior dimension as identified on drawings. Carrier pipe manufactured by Aquatherm Greenpipe/Climatherm or approved equal.
 - b. Fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 100 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - e. Fittings and joint closures shall consist of polyurethane foam with PE cover or sleeve and pressure sensitive tape.
 - f. Warranty: Minimum 2 years.
 - g. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
4. Copper Pipe: Preinsulated pipe with jacket. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Copper-Therm, Perma-Pipe, Rovanco or equal.
 - a. Carrier pipe. Copper ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure.
 - b. Fittings: Factory fabricated and insulated with polyurethane foam and one-piece molded Polyethylene cover.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.

- e. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
5. Fiberglass Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Fiber-Therm 250, Perma-Pipe, Rovanco, or equal.
- a. Fiberglass pipe: conforming to MIL-SPEC P28584A and P22245A. Minimum wall thickness 0.180 inches. Series 2000 Bondstrand, Smith Red Thread II filament wound fiberglass or approved equal.
 - b. Fittings: Bell and spigot type joined by thermosetting epoxy resin. Connection to steel pipe with flanged fittings.
 - c. Casing: Polyurethane insulation with jacket and heat shrink sleeves.
 - d. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - e. Jacketing Material: Seamless polyvinylchloride (PVC) conforming to ASTM 1784 or high density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 100 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - f. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
 - g. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
6. Carbon steel pipe: Preinsulated pipe with jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco, or equal.
- a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
 - b. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
 - e. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

7. Stainless Steel Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco, or equal.
 - a. Carrier pipe: Stainless steel 316/316L Alloy, ASTM A312, Schedule 40 or Schedule 80. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
 - b. Fittings: ASTM A403. Shall be factory preinsulated.
 - c. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - d. Casing: Polyurethane insulation with jacket and heat shrink sleeves.
 - e. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - f. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
 - g. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
 - h. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

- B. Condenser Water Piping
 1. Ductile iron pipe as manufactured by US Pipe and Foundry or equal.
 - a. Pipe: Restrained joint ductile iron pipe manufactured in accordance with ANSI/AWWA C151/A21.51. Pipe thickness shall be in accordance with ANSI/AWWA C150/A21.50.
 - b. Joints:
 - 1) Ductile Iron Push-On Joint Type: 250-lb. working pressure, ductile iron, ANSI/AWWA C110/A21.10 and C111/A21.11, Tyton type push-on joints with SBR rubber ring gaskets.
 - 2) Ductile Iron Mechanical Joint Type: 250-lb. working pressure, ductile iron, ANSI/AWWA C110 and C111, mechanical joints with SBR rubber ring gaskets. Flanged outlets shall conform to ANSI B16.1, 125 lb.
 - c. Pipe coating: all underground exposed ferrous pipe and fittings in corrosive soil conditions shall be covered with one of the following methods:
 - 1) Twice Wrap 20 Mill Scotch Wrap PVC No. 51, 50% overlap.
 - 2) Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mill Scotch Wrap No. 51.
 2. Polyvinylchloride (PVC) Schedule 80 Pipe: Pre-insulated pipe with jacket. Pipe system shall be manufactured by Thermacor #Chill-Therm, Perma-Pipe, Insul-Pipe Systems, Rovanco or equal.
 - a. Carrier Pipe: All PVC Schedule 80 pipe shall be manufactured in conformance to ASTM D1785 or ASTM D2241. Maintain minimum interior dimension as identified on drawings.

- b. Fittings and joints joined using solvent weld glue and are manufactured from PVC material which meets or exceeds requirements of ASTM D1784, cell classification 12454B, Type 1, Grade 1. Fittings and couplings shall be field insulated per manufacturer requirements.
 - c. Insulation: Polyurethane foam with K-factor = 0.13, density = 2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1 inch.
 - d. Jacketing Material: Seamless Polyvinylchloride (PVC) meeting the specifications of ASTM D1784 or high density polyethylene (HDPE), conforming to ASTM D1248. Minimum wall thickness of 0.06 inches for the PVC jacketing material and 80 mils for the HDPE jacketing material.
3. High Density Polyethylene (HDPE): Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Polycor, Perma-Pipe, Rovanco or equal.
- a. Carrier pipe: Pipe shall be manufactured from a high density polyethylene (HDPE) conforming to ASTM D3350 and D2837 with SDR wall thickness based on design temperature and pressure requirements ranging up to 255 psi and maximum operating temperature of 140°F. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria. Maintain minimum interior dimension as identified on drawings.
 - b. Fittings and joints using butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing (minimum). Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 100 mils for small pipe diameters up to 150 mils for large diameters.
 - e. Joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and pressure sensitive tape.
 - f. Warranty: Minimum 2 years.
 - g. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
4. Plastic (Polypropylene) Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Rovanco or approved equal.
- a. Carrier pipe: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. All pipes shall be made in a three-layer extrusion process. Piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipes shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria. Maintain minimum interior dimension as identified on drawings. Carrier pipe manufactured by Aquatherm Greenpipe/Climatherm or approved equal.

- b. Fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 150 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - e. Fitting and joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and pressure sensitive tape.
 - f. Joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and pressure sensitive tape.
 - g. Warranty: Minimum 2 years.
 - h. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.
5. Copper Pipe: Preinsulated pipe with jacket. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Copper-Therm, Perma-Pipe, Rovanco or equal.
- a. Carrier pipe. Copper ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure.
 - b. Fittings: Factory fabricated and insulated with polyurethane foam and one piece molded Polyethylene cover.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - e. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
6. Fiberglass Pipe. Pipe system shall be manufactured by Thermacor Fiber-Therm, Perma-Pipe, Rovanco or equal. On-site training and inspection of joint closures and installation shall be provided by factory certified representative.
- a. Fiberglass pipe: conforming to MIL-SPEC P28584A and P22245A. Minimum wall thickness 0.180 inches. Series 2000 Bondstrand, Smith Red Thread II filament wound fiberglass or approved equal. Maintain minimum interior dimension as identified on drawings.

- b. Fittings: Bell and spigot type joined by thermosetting resin. Connection to steel pipe with flanged fittings.
7. Carbon Steel Pipe: Preinsulated pipe with jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco or equal.
- a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
 - b. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
 - e. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
8. Stainless Steel Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco or equal.
- a. Carrier pipe: Stainless steel 316/316L Alloy, ASTM A312, Schedule 40 or Schedule 80. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
 - b. Fittings: ASTM A403. Shall be factory preinsulated.
 - c. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - d. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - e. Jacketing Material: Seamless polyvinylchloride (PVC) conforming to ASTM 1784 or high density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - f. Joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and heat shrink sleeve.
 - g. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
- C. Heating Water Piping (Maximum operation temperature of 250°F)

1. Copper Pipe: Preinsulated pipe with jacket. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Copper-Therm, Perma-Pipe, Rovanco or equal.
 - a. Carrier pipe. Copper ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure.
 - b. Fittings: Factory fabricated and insulated with polyurethane foam and one piece molded Polyethylene cover.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - e. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
2. Carbon Steel Pipe: Preinsulated pipe with jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco or equal.
 - a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
 - b. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
 - e. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
3. Stainless Steel Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco or approved equal.
 - a. Carrier pipe: Stainless steel 316/316L Alloy, ASTM A312, Schedule 40 or Schedule 80. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.

- b. Fittings: ASTM A403. Shall be factory preinsulated.
 - c. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
 - d. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - e. Jacketing Material: Seamless polyvinylchloride (PVC) conforming to ASTM 1784 or high density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - f. Joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and heat shrink sleeve.
 - g. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
4. Fiberglass Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Fiber-Therm 250, Perma-Pipe, Rovanco or equal.
- a. Fiberglass pipe: Conforming to MIL-SPEC P28584A and P22245A. Minimum wall thickness 0.180 inches. Series 2000 Bondstrand, Smith Red Thread II filament wound fiberglass or approved equal. Maintain minimum interior dimension as identified on drawings.
 - b. Fittings: Bell and spigot type joined by thermosetting epoxy resin. Connection to steel pipe with flanged fittings.
 - c. Insulation: Polyurethane foam with K-factor=0.165 (maximum), density=2 pcf (minimum), closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
 - d. Jacketing Material: Seamless polyvinylchloride (PVC) conforming to ASTM 1784 or high density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.
 - e. Joint closures shall consist of polyurethane foam, Zeston or PE cover or sleeve and pressure sensitive tape.
 - f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings and one copper wire mounted adjacent to the non-conductive pipe carrier.

2.02 VALVES

- A. All valves shall be designed for Class 150 pipe systems and shall open by turning the stem counterclockwise.
- B. Buried Butterfly Valves (2" and larger): Valves shall be mechanical joint, rubber-seated butterfly valves conforming to AWWA Standard C504 Class 150B. Buried valves shall be equipped with a 2" square operating nut. Buried valves shall be bituminous coated and shall be provided with an extension stem equipped with a 2" square operating nut. Extension stem shall extend to within 18" of top of valve box.
- C. Manufacturers: Henry Pratt (Mueller) #Groundhog, Milwaukee #Ultra Pure CL series, or equal.

2.03 TAPPING SLEEVE AND TAPPING VALVE

- A. Cast iron mechanical joint type sleeve, sized specifically for actual O.D. and piping material, Koppel, Mueller, Clow or equal.

2.04 VALVE BOXES

- A. Cast iron valve boxes for shutoff valves buried in ground shall be complete with bell bottoms, extension piece, top and cover. Boxes shall be suitable for the types of valves with which they are used. All valve boxes shall have a concrete collar flush with grade.
- B. Lids shall have the applicable letters embossed upon the top surface. Tagging shall match existing lids.
- C. Manufacturer: Tyler, ITT Grinnell, Mueller or Kennedy.

2.05 PIPE LOCATING WIRE AND MARKER

- A. Pipe Locating Wire: Bare AWG No. 10, soft drawn, single strand copper wire.
- B. Provide at least six mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.
- C. Pipe marker shall be internal with locating wire color coded for use with different utility pipe systems, and marked with the utility tape every 24 inches. Provide 4 mil thick, 4"inch wide polyethylene marker.

2.06 THRUST BLOCKS

- A. Provide 2,000 psi concrete thrust blocks at changes in pipe direction, changes in pipe sizes, dead-end stops and at valves.
- B. Calculate area of undisturbed earth of thrust block based on 2000 psi soil and 150 psi water test pressure.
- C. Concrete and reinforcing steel shall be as specified in Divisions 03 and 05. All concrete shall be Class A, unless specified otherwise.
- D. Miscellaneous nuts and bolts shall be stainless steel.

2.07 ANCHORS

- A. Pre-fabricated anchors shall be furnished and installed in pipe systems as required by piping system manufacturer. Anchors shall consist of steel pipe welded to pipe and conduit. The steel anchor plate shall be 1/2" thick and extend a minimum of 1-1/2" beyond the outside jacket.

2.08 RODS AND CLAMPS

- A. Socket clamps shall be stainless steel, four bolt type, equipped with stainless steel socket clamp washers and nuts. Anvil Fig. 595 and 594, B-Line B3134, or equal.
- B. Rods shall be stainless steel.

2.09 MECHANICAL SLEEVE SEALS

- A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- B. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.
- C. Manufacturer: Metraflex #Metraseal, Advance Products & Systems #Innerlynx, GPT #Link-Seal, or equal.

2.10 TEST CONNECTIONS

- A. Saddles shall be of malleable or ductile iron, with neoprene gasket and 3/4" N.P.T. female pipe connection, Smith Blair No. 311, Rockwell International No. 331.
- B. Valves shall be 3/4" - 300# bronze globe with composition disc. NOTE: When all tests have been completed, valve and pipe nipple shall be removed from the saddle and a forged steel pipe plug shall be inserted.

2.11 DIRECT-BURIED CONTROLLED DENSITY THERMAL INSULATION

- A. Extent of underground piping insulation is indicated on drawings. Insulation is inorganic engineered granular mix. Product must consist of insulating minerals (sodium potassium aluminum silicate) and dielectric mineral filler (coated calcium carbonate). Material shall be dry, free-flowing, inert, inorganic, non-toxic, non-flammable, and completely free of asbestos and fibers. Material to be chemically treated to render it hydrophobic. Product is NOT to rely upon polyethylene barrier to prevent: foreign object/soil intrusion, material protection or direct contact of water. Underground fill product must consist of well-graded, multi-sized and shaped particles and raw material must be dimensionally stable. Insulation material must be able to be mechanically compacted.
- B. Applicable Codes and Standards:
 - 1. ASTM C-177-04 Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - 2. ASTM D-1895 Apparent Density, Bulk Factor and Pourability of Plastic Materials.
- C. Manufacturer:
 - 1. Gilsulate #500XR, Gilsulate, Santa Clarita, CA 91350, 800-833-3881, www.gilsulate.com, or equal.
- D. Physical Properties:
 - 1. ASTM C177-04 Thermal Conductivity (tested @ use density):
 - a. $K = 0.53 \text{ Btu/hr.ft}^2 \text{ }^\circ\text{F/in. @ } 100^\circ\text{F Mean Temp}$
 - b. $K = 0.60 \text{ Btu/hr.ft}^2 \text{ }^\circ\text{F/in. @ } 175^\circ\text{F Mean Temp}$
 - 2. ASTM D1895A – Bulk Density: 30-34 lbs./ft³.
 - a. ASTM D1895C (400 lbs.) – Consolidated Cubic Foot Installed/Use Density (CFUD): 40-42 lbs./ft³ CFUD.
 - 3. ASTM D1895C (400 lbs.) – Percent of compaction of installed density under static load
 - a. Shall not exceed more than 1% compaction

4. ASTM D1895C – Material Bearing Under Applied Static Loading: 12,000 PSF.
5. Particle Sizing Range: “Well-graded” diameter ranging from 1 mm to sub-micron sizes.
6. Material Stability: Material for direct-buried application must support weight of a man prior to backfill placement.
7. Temperature Range: 35°F to 800°F
8. Electrical Resistivity: Greater than 10 to the 12th Ohm-cm.

E. ACCESSORIES

1. Protective Coatings: provide a bitumastic self-priming, heavy duty, cold-applied, waterproof coating made from pitch derived from tar and solvents. Approved product: Carbolite “Bitumastic 50” or equal.
2. Structural Steel Components: provide steel anchors and guides as required by the contract documents and insulation manufacturer's drawings and Design and Installation Manual.
3. Expansion Cushions: provide 3 to 5 pound density mineral fiber cushion to accommodate thermal expansion at expansion loops and elbows as required by the contract documents and insulation manufacturer's drawings and Design and Installation Manual.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Have on hand all installation manuals, brochures, and procedures for the equipment and materials concerned.
 1. Follow manufacturer's instructions, where such are provided, in all cases that cover points not shown on the Drawings or specified herein.
 2. Manufacturer's instructions do not take precedence over the Drawings and Specifications.
 3. Where manufacturer's instructions are in conflict with the Drawings and Specifications; submit the conflicting instructions to the Owner's Representative for clarification before performing the work.
 4. Use fittings to make all changes in direction and size unless otherwise shown on the Drawings.
 5. Maintain factory plastic end covers on the pipe during storage. Caps shall be removed upon installation of pipe to insure cleanliness.
 6. Manufacturer piping drawings for expansion and contraction.
- B. Representative of System Manufacturer: This shall be a person who regularly performs the duties listed below, is certified in writing by the system manufacturer to be technically qualified and experienced in the installation of the system, and shall be authorized by the manufacturer to make and sign the daily reports specified herein. The representative shall be responsible for training and supervision of the installing workers. This is to include the following services and/or training.
 1. Inspection of material delivered to site.
 2. Inspection of concrete anchors.
 3. Field joint closure work.

4. Repair of any coatings.
 5. Holiday test of steel piping systems.
 6. Installation and testing of cathodic protection systems. Coordinate with Div 26 installer and Section 26 42 00 Cathodic Protection.
 7. The slope of the system. Elevation readings shall be witnessed and recorded.
- C. Protect casing coating from damage during rigging, storage and installation. Protect casing and carrier pipe ends from water intrusion during rigging and installation. Protect casing coatings from ultraviolet light (sunlight).
- D. Defective Material: The Representative shall take prompt action to return to the factory damaged or defective material and shall order prompt replacement of such material.
- E. Cleaning of Piping: Remove dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections.
- F. Wet Insulation: Sections of system, which have been fully or partially submerged in water, must be replaced. Moisture content of insulation shall not exceed five percent by weight.
- G. Vents and Drains at Ends of System: At each casing termination (end plate) in building, plug the casing drain openings with brass plugs and extend one-inch pipe size vent pipes from the casing vents to one foot above the conduit in buildings.

3.02 CATHODIC PROTECTION OF METAL PIPE

- A. Cathodic Protection: Provide cathodic protection for steel piping/casing systems and buried exposed metal to minimize corrosion potential. Assume that 25 percent of the exterior of the steel casing is exposed metal. Cathodic protection systems shall have a minimum design life of 25 years and shall be designed in accordance with recommendations of NACE SP0169 (latest edition). Provide all anodes, wiring, dielectric pipe flange kits, and any additional required isolation devices, at points necessary within vaults or at building terminations. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure. Coordinate with electrical design per Section 264200 Cathodic Protection.

3.03 MECHANICAL SLEEVE SEALS

- A. Install mechanical link seal(s) where piping penetrates an exterior walls or floors. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

3.04 TRENCH, EXCAVATION AND BACKFILL

- A. Conform to requirements of Division 02.
- B. Install all utilities with a minimum 36" cover over the crown of the pipe.
- C. Provide all necessary shoring, sheeting, pumping as part of work of this division.
- D. Dig trenches straight, true to line and grade with bottoms smoothed of any rock points. Excavate 3" below grade of pipe, fittings, hubs, couplings, etc., using templates to fit outside periphery of lower third of piping.

- E. Excavations for trench may be by machine or by hand with special care used around buried utilities and trees shown on Contract Drawings.
- F. All excavations shall be carefully done to avoid "over-digging" and backfilling the bottom of trench before pipe is installed in the trench.
- G. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12" above the pipe crown where located outside the building footprint, and not less than 2" above pipe crown where pipes are located within the building footprint. Use thin layers of unwashed sand, dampened but not puddle, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6" and tamped by mechanical tampers to a minimum 90% Modified Proctor Density, in accordance with ASTM D-1557-58T or greater as defined by elsewhere in construction documents. Alternate backfill material may be Class I or II SE-30+ fill with minimum 30 percent sand and maximum 1/2" diameter particle size.
- H. Trench width and special instructions necessary to correctly install pipe and fittings shall be as recommended by the pipe manufacturer.
- I. Special preparation shall be taken to keep the inside of the piping clean of all debris, especially sand and dirt, during installation and testing. Maintain factory covers on open ends of pipe until lowered into trench.
- J. After testing and acceptance, the trench shall be backfilled with native backfill for the first 12" depth, then wetted and hand tamped, refilled with the native backfill to approximately 12" over top of pipe, wetted again and hand tamped firm. Mechanical tamping of rock-free soil shall be carefully done to achieve a minimum of 90% compaction at depth of 12" and below, and to 95% for top 12" depth.
- K. Provide precast monument set flush with surface in paved area to locate branch connection.

3.05 UNDERGROUND PIPING INSTALLATION

- A. Remove loose rock, clods, and debris from the trench before placing bedding sand, and before laying any pipe.
- B. Before placement of pipe, a sand bed shall be prepared in the following manner:
 - 1. Trench shall be backfilled with sand to a minimum depth of 6".
 - 2. Sand shall be compacted sufficiently to prevent settlement of pipe.
 - 3. The pipe shall be made up with the pipe barrel bearing evenly along its full length on the sand bed on the bottom of the trench.
 - 4. In the case of steel or other rigid joint piping, excavate holes under joints and connections for access for making up, welding, testing, and wrapping joints.
- C. Thoroughly clean each section of pipe and fitting before lowering into the trench. Clean each pipe or fitting by swabbing-out, brushing-out, blowing-out with compressed air, washing-out with water, or by any combination of these methods necessary to remove all foreign matter.
- D. If cleaned pipe sections and fittings cannot be placed in the trench without getting dirt into the open ends, tie tightly woven canvas or other type of approved cover over the ends of the pipes and fittings until they have been lowered into position in the trench. After removal of the covers in the trench, completely remove foreign matter from the pipe ends and fittings.

- E. Do not lower any pipe or fitting into a trench that contains water.
 - 1. Pump water from wet trenches, and keep the trenches dry until the joints have been completed and the open ends of the pipes have been closed with watertight plugs or bulkheads.
 - 2. Whenever pipe installation is discontinued on any job for short periods or whenever work is stopped at the end of the day, close the open ends of the pipe with watertight plugs or bulkheads. Do not remove the plug or bulkhead unless the trench is dry.
 - 3. Keep the trench dry at all times.
- F. Assemble lengths of pipe such that centerline of two pipes being joined do not form an angle exceeding 2 degrees in any plane. In addition, the angle formed in the vertical plane shall not exceed 1-1/2 degrees.
- G. Weld pipe joints in accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0°F.
 - 2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
 - 3. Use pipe clamps or tack-weld joints with 1" long welds and four (4) welds for pipe sizes to 10".
 - 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
 - 5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
 - 6. With engineering pre-approval stub-in saddle taps may be acceptable for branch connections where the branch size is less than 50% of the main size and where branch sizes are 2", or smaller, in diameter.

3.06 SLOPING, AIR VENTING, AND DRAINING

- A. Slope all piping mains to allow for drainage at low points. Slope shall not exceed 1%. Provide drain valves and hose adapters at all low points in piping inside the building or exterior concrete vaults.
- B. Connect all water branch piping to the top or side of their respective mains. All branch piping shall slope upwards towards the building riser at a maximum slope not exceeding 1%.
- C. Provide manual or automatic vents at all high points in water piping as specified elsewhere in the specifications.

3.07 LOCATING WIRE AND MARKER TAPE

- A. Pipe locating wire shall be provided for the entire length of all pressure pipelines except for metallic piping.
- B. Install locating wire by strapping to the pipe or tubing with PVC tape, polyethylene backed tape, or tie locks. Test pipe locating wire with pipe locator equipment prior to final acceptance of pipeline.

- C. Stub the locating wire up inside each valve box. Sufficient excess length shall be provided at terminal connections to allow continuation of locating wire to the terminal connection.
- D. Wire splices shall be made with compression fittings or soldering; wrapped with Tac-Tape, Aqua-Seal; and wrapped with electrical tape. Prevent bare copper wire from contacting metallic appurtenances including, but not limited to, pipe, buried valves, or fittings.

3.08 LEAK DETECTION MONITORING WIRE FOR BURIED PIPE

- A. The piping system shall be provided with leak detection monitoring wire by means of installing a bare copper wire between the carrier pipe and the jacket. The piping system manufacturer shall install the wire in a manner that has the wire embedded in the foam insulation and incorporated into each piece of pre-insulated pipe and fittings. Installer shall check continuity and electrical isolation of each piece of insulated pipe and fittings with a standard ohmmeter as it arrives at the jobsite. Installer shall connect the copper wires together at each field joint with the insulated jumper cables and recommended crimping tool as per manufacturer's instructions.
- B. Wire leads shall be looped, minimum 12" exposed, and tagged at each end of the buried piping system for connection to alarm monitoring panel(s) and future maintenance monitoring by the Owner using portable resistance metering.
- C. Installer shall then check for continuity and electrical isolation using a standard ohmmeter over the length of the installed piping system before insulating straight run joint kits. When required contractor will have to make provisions for running the wire in and out of vaults. The reading on the ohmmeter should be close to infinity for any single piece, and not less than 1 Million Ohms for an entire run.
- D. After the piping system is installed, the owner at any time may check the system for a leak by using a standard analog volt ohmmeter. One ERM (electric resistance monitoring) panel shall be installed for each piping system to monitor up to 2000' of piping length. The ERM alarm single shall have output contacts for connection to the BAS with connection by the controls installer. Coordinate with the BAS installer for location of alarm panel(s) and contact connections. If the ERM panel alarms, indicating a leak has been detected, the Owner should contact the system manufacturer for a technician to come to the site to determine the location of the leak with a TDR (time domain reflectometer) instrument.

3.09 CONNECTIONS TO EXISTING UTILITY MAINS

- A. Install tapping sleeve and tapping valve with flanged designed outlet for existing pipe connection. Follow manufacturer's installation recommendations. The use of pipe freezing technology may be utilized for hot tapping existing line with prior Owner approval.
- B. Under no circumstances shall existing lines or utilities be interrupted without prior approval of the Owner's Representative. Submit the request for this approval to the Owner's Representative in accordance with Division 01, and also state the maximum duration of shutdown.
- C. Schedule all outages for utility tie-in work well in advance and give written notice to the Owner's Representative in accordance with Division 01.

- D. In preparation for tie-ins to existing on-site utility systems, the Owner will drain and/or blow the existing piping prior to start of tie-in work by the Contractor. In all cases, the Owner will close the appropriate valves to isolate the area of work. The Contractor shall be responsible for refilling the system including all approved chemical treatment. The Contractor shall be responsible for venting the isolated portion of the existing chilled water mains affected by the work of this project.

3.10 CONCRETE

- A. Conform to requirements of Division 03.
- B. Install thrust blocks and anchors as per pipe manufacturer's recommendations.
- C. Provide concrete thrust blocks for piping. Concrete thrust blocks shall be poured and set before pressure testing.
- D. Concrete thrust blocks shall be installed at all fittings and at all changes of direction whether shown on drawing or not.
- E. Thrust blocks shall be formed on the sides to establish a definite shape and limit on height and width subject to approval before ordering concrete. Make-shift and ill-fitting forms will not be accepted. Forms shall be removed before backfilling.
- F. Thrust blocks shall be allowed to cure a minimum of 3 days before water pressure is applied to any part of the system and before forms are removed.

3.11 FLUSHING

- A. The entire new piping system shall be thoroughly flushed out until reasonably clean in the opinion of the Owner's Representative.
- B. All tests shall be conducted at such times as directed by and in the presence of the Owner's Representative.

3.12 PIPE TESTING

- A. Chilled water, condenser water, and heating water piping shall be hydrostatically tested to prove watertight prior to backfilling. Provide all instruments, facilities, and labor to conduct testing and placing in operation. In addition, piping systems with integral airtight external casings shall have the casing air tested to 15 psig with no leaks for two hours.
- B. Piping shall be tested in whole or in sections. Testing under this section of the work shall be done before final connections to building piping and existing utility piping is made, with the provision that subsequent leaks, if developed, at these conditions shall be corrected under this section of the work.
- C. Any part of any piping system, including all accessories, that shows failure during testing shall immediately be repaired or replaced with new materials. The system shall be completely retested after repair or replacement. This procedure shall be repeated, if necessary, until all parts of all systems withstand the specified tests. All retesting costs shall be part of the Contract.

- D. Holiday testing of direct-buried steel piping and casing systems: Test entire surface of piping and casings for faults in coating, after installation in trench, and prior to backfilling. Use test method and voltage recommended by coating manufacturer. Repair any holidays found and retest. System shall not be backfilled until holidays are eliminated.
- E. Test time for final pressure test will be accrued only while full test pressure is on the entire piping system. Pressure tests shall be witnessed by the Owner's Representative. Provide minimum 48-hour notice prior to start to each test. "Tolerance" shall be no perceptible pressure drop, except that due to temperature change in a 24-hour test period (minimum). Inspect and test all work prior to burying or concealing. Test pressure shall be 100 psig or 1.5 times the system operating pressure, whichever is greater. If approved by the local Authority Having Jurisdiction, the maximum test pressure may be limited to 50 psi greater than the operating pressure, but in no case less than 100 psig. Test pressure shall be applied and measured at the lowest floor level of the piping system. Confirm maximum pressure testing requirements with pipe manufacturer and do not exceed the maximum pressure rating of the piping.

3.13 CLOSING OF UNINSPECTED WORK

- A. No work shall be covered up or enclosed until the opportunity to inspect and test same has been afforded to the Owner's Representative and the Owner's Representative has authorized the Contractor to cover or enclose the work.
- B. Any work enclosed or covered in the absence of the Owner's Representative's authorization shall be uncovered. All expense to comply shall be borne by the Contractor.

3.14 INSTALLATION OF DIRECT-BURIED CONTROLLED DENSITY THERMAL INSULATION

- A. Install and test carrier pipe: Install and test prior to installing insulation. Inspect welds and pressure test pipe as required by other sections of this specification. Clean pipe of all dirt, scale and foreign materials.
- B. Installation of temporary pipe supports: Provide temporary pipe support wires suspended from lumber bridging the trench. Temporary wood blocks located under the pipe may also be used. These supports must be removed as the insulation is poured and consolidated. No object should be allowed to bridge the gap between the soil and the pipe except the insulation.
- C. Installation of expansion cushions: Wrap mineral fiber cushions around pipe elbows on expansion elbows and expansion loops as indicated on the contract documents. Insure there is sufficient space or flexibility between cushions to allow insulation to pour and be consolidated under piping. Secure cushion to pipe with fiber reinforced tape. Specified Insulation thicknesses need to be maintained around fiber cushion areas.
- D. Installation of forms: Provide gypsum board forms with support posts as shown in Gilsulate International, Inc.'s Design and Installation Manual. Posts must be located on the outside of the forms and spaced to prevent bowing of the gypsum board. After forms are in place, partially backfill outside of form to height of pipe.
- E. Pouring of insulation: Pour insulation in short sections along the pipe axis. Apply bitumastic to structural steel surfaces and fill trench to centerline of pipe. Consolidate insulation using a rod-type concrete vibrator pulled along the sides and between the pipes. Pour and consolidate additional layers of insulation until the design coverage has been achieved. Proper consolidation is achieved when the insulation can be walked on with footprints less than 1" deep. No wood is to remain in contact with pipes or left in insulation envelope. This could affect overall system efficiency (heat gain/loss) of non-metallic pipe(s) and/or cause corrosion to metallic pipes.

- F. Inspector must physically be capable of confirming specified installed/compacted insulation thicknesses prior to placement of any backfill.
- G. Backfill first 6" of soil (no stones) by hand. Complete backfilling and mechanically compact in uniform layers with suitable excavated soil to grade level.
- H. Refer to Gilsulate International Inc. "Design & Installation Manual for Installation Procedures.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. In-line close coupled pumps.
 - 2. Suction diffusers.
 - 3. Basket strainers.
 - 4. Electronically commutated motors.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 05 93 - Testing, Adjusting and Balancing.
- C. Section 23 09 00 - Building Automation System (BAS) Controls.
- D. Section 23 09 02 - Variable Frequency Drives (VFD).
- E. Section 23 21 13 - Hydronic Piping, Valves and Specialties.
- F. Section 23 31 13 - Air Distribution.
- G. Section 23 52 00 - Non-Condensing Boilers.
- H. Section 23 52 16 - Condensing Boilers.
- I. Section 23 52 20 - Steam Boilers.
- J. Section 23 57 00 - Heat Exchangers for HVAC.
- K. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.
- B. Codes and Standards: Provide pumps which conform to the requirements of the following standards.
 - 1. Hydraulic Institute (HI): Manufacturer pumps in accordance with "Standards for Centrifugal Rotary and Reciprocating Pumps."
 - 2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
 - 3. National Fire Protection Association (NFPA)-70: National Electrical Code.
 - 4. Underwriters Laboratories (UL) UL-778: Motor Operated Water Pumps.
 - 5. Code or Federal Regulations 431.465: Pumps energy conservation standards effective January 27, 2020.

1.05 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

1.06 PUMP ENERGY CONSERVATION STANDARDS

- A. Each pump manufactured after January 27, 2020 shall not exceed the maximum PEI of 1.00 as defined by Section §431.465 of the Code of Federal Regulations.
- B. Definitions:
 - 1. PEI_{CL}: The constant load pump energy index.
 - 2. PEI_{VL}: The variable load pump energy index.
 - 3. BEP: The best efficiency point as determined in accordance with the test procedure in §431.464 of the Code of Federal Regulations.
- C. Pump Applications:
 - 1. ESCC: End suction close-coupled.
 - 2. ESFM: End suction frame mounted/own bearings.
 - 3. IL: In-line close coupled or split coupled.
 - 4. RSV: Radially split, vertical, multi-stage, in-line diffuser casing.
 - 5. ST: Submersible vertical turbine with 6 inch or smaller bowl diameter.
 - 6. Exception for the following type of pumps:
 - a. Fire pumps.

- b. Self-priming pumps.
- c. Split-case pumps.
- d. Prime-assist pumps.
- e. Magnet driven pumps.
- f. Pool pumps.

D. Pump Operating Conditions:

1. Flow rate: 25 gpm or greater at BEP and full impeller diameter.
2. Maximum head: 459 feet at BEP and full impeller diameter.
3. Design temperature: 14 to 248°F (-10°C to 120°C).
4. Pole: 2- or 4-pole induction motors.
5. Nominal speed of rotation: 1800 rpm or 3600 rpm.
6. Operating mode : CL = constant load or VL = variable load.

E. Pump Labeling Requirements:

1. In addition to manufacturer performance data each pump shall be permanently labeled with the following energy efficiency data:
 - a. Rated pump energy index: PEI_{CL} or PEI_{VL} .
 - b. Impeller diameter.

1.07 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.
 2. Submittal information to verify all scheduled characteristics are met including efficiency.
- B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.
- D. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

- B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.09 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 IN-LINE CLOSE COUPLED PUMPS

- A. Furnish and install pumps with capacities as shown on plans on a factory installed skid manufactured. Pumps shall be in-line type, close coupled, single stage design, for installation in vertical or horizontal position, and capable of being serviced without disturbing piping connections.
- B. Pump casing shall be ductile iron, and impeller shall be of stainless steel enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew. Impeller trim shall be optimized for best efficiency safety factor..
- C. The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A bronze shaft sleeve shall completely cover the wetted area under the seal.
- D. Pumps shall be rated for minimum of 175 psi working pressure. The pump case shall have gauge tappings at the suction and discharge nozzles and will include vent and drain ports.
- E. Motor shall be IE5 ECM TEFC and shall be of the size, voltage and enclosure called for on the plans. It shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed.
- F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
- G. Manufacturer: Armstrong, Xylem Bell & Gossett #80 Series, Grundfos, or equal.

2.02 SUCTION DIFFUSERS

- A. Provide suction diffuser at inlet to pump unless otherwise shown on plans. Suction diffuser shall have an angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 2-1/2 times the diameter of the system suction connection.
- B. Suction Diffuser shall include the following features:
 - 1. Suction diffuser body shall be made of either cast iron or ductile iron.

2. Include a full-length, 4-plane, removable straightening vane.
 3. Straightening vane shall be made of either carbon steel or 304 stainless steel.
 4. Orifice cylinder shall be made of 304 stainless steel, or better.
 5. Flanged end connections or grooved end connections.
 6. Flange end connections should be designed according to ANSI Class 150 Standards.
 7. Strainers shall be rated for 150% (minimum) of the working pressure of piping system
 8. Strainer orifice cylinder (basket) shall be full length and removable.
 - a. Start-up screen for first month of operation shall be a 40 mesh with 0.016" openings and 41% open area.
 - b. Start-up screen shall be removed and replaced with normal operation cylinder after one month of pump operation, or as directed by the water treatment company, and prior to final water balance.
 - c. Normal operation orifice cylinder shall include 3/64" diameter perforations with 51% open area (minimum).
- C. Manufacturer: Xylem Bell & Gossett, TACO, Patterson, Wheatley, Victaulic or equal.

2.03 BASKET STRAINERS:

- A. Provide strainers full line size of connecting piping, with flanged ends to match piping system.
- B. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 150% (minimum) of the working pressure of piping system
- C. Body with bolted cover and bottom drain connection: ASTM A126, Class 125, high-tensile cast iron. Or, ASTM A216, Class 150, cast carbon steel. Or, ASTM A351, stainless steel.
- D. Cover with O-ring seal and quick release knob fasteners up to 8" size and bolted cover for 10" and larger.
- E. Strainer screen or basket, Type 304 stainless steel or better.
 1. Start-up screen for first month of operation shall be a 40 mesh with 0.016" openings and 41% open area.
 2. Start-up screen shall be removed and replaced with normal operation basket after one month of pump operation, or as directed by the water treatment company, and prior to final water balance.
 3. Normal operation perforated basket, shall be installed prior to final water balance, shall be provided with 3/64" diameter perforations with 36% open area (minimum).
- F. Manufacturer: Spirax Sarco, Keckley, Wheatley, Mueller, or equal.

2.04 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.

3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0 to 10 Vdc or 4 to 20 mA input.
6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 EXECUTION

3.01 INSTALLATION

- A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Grouting Pump Base: For all base mounted flexibly coupled pumps fill the pump base frame with grout after completing pump/motor alignment.
- C. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc., as specified in related specification sections. Refer to Section 230548 for additional requirements.
- D. For variable flow pumping applications refer to Section 230902 for additional requirements.
- E. Mechanical contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.
- F. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.
- G. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.
- H. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by replacing the impeller to match the load.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four-hours travel from the jobsite.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. Includes, but not limited to:
 1. Furnish and install piping and piping specialties for refrigeration systems serving split system air conditioning units.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods.
- B. Section 23 07 19 - HVAC Piping Insulation.
- C. Section 23 81 30 - Split Air Conditioning Units.
- D. Division 26 - Electrical.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the requirements of the latest addition of the following:
 1. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications" latest edition.
 2. ASHRAE 15: Safety Code for Refrigeration Systems.
 3. ASME B31.5: Refrigeration Piping and Heat Transfer Components.
 4. ASTM B 280: Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service.

Internal Working Pressure of Copper ACR Tube per ASTM B280			
Nominal Or Standard Size (Inches)	Annealed	Annealed Lengths Lengths	Hard Lengths Lengths
1/8	2459	NA	NA
3/16	1548	NA	NA

1/4	1102	NA	NA
5/16	957	NA	NA
3/8	787	731	1569
1/2	581	625	1341
5/8	494	579	1242
3/4	409	506	1086
7/8	466	467	1002
1-1/8	395	396	850
1-3/8	351	352	755
1-5/8	327	327	702
2-1/8	NA	291	625
2-5/8	NA	269	577
3-1/8	NA	254	545
3-5/8	NA	243	522
4-1/8	NA	235	504

- B. Contractor Qualifications: A refrigeration contractor licensed by the State shall install refrigerant piping.
- C. Manufacturer Qualifications:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
 2. Replacement parts shall be readily available and stocked in the USA.
 3. Manufacturer shall have a minimum of five years of manufacturing products related to refrigerant piping and/or fittings.
 4. Products shall have an installation history of no less than five years of field operation with reliable maintenance track record.
 5. Alternate system and material must be submitted with historical supporting documentation and reliability report before approval is allowed.
- D. Codes and Standards:
1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
 2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes for work required, but not specifically shown in Drawings.
 3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
 4. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and so identified.
- E. Product Control
1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
 2. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, pipe sizes, fittings sizes, rises and drops in piping that may be necessary, whether shown or not, shall be

made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.

3. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
 4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.
 5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
 6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.
 7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
 8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Owner's Representative and receive clarification before installing the work.
 9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.
 10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
 11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.
- F. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test

report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for all refrigerant piping, valves and specialties indicating dimensions, flow capacity, pressure setting, tolerances etc.
- B. Shop Drawings:
 - 1. Submit shop drawings including plans, schematics, and riser diagrams of refrigerant piping, including dimensions of all piping.
 - 2. Reference to associated insulation systems submitted in compliance with Section 23 07 19 HVAC Piping Insulation.
 - 3. Provide all details of suspension and support for ceiling hung equipment.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.07 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.
- C. Provide the following additional extended warranty requirements that apply to piping with mechanical type joints and fittings, such as grooved or pressed/compression type fittings.
 - 1. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.
 - 2. Contractor and Manufacturer warrant that, for a period of ten (10) years from the date of Substantial Completion, the entire system, including but not limited to the fittings and

joints, will conform to the requirements of the Contract Documents, will be free from defects, and will not leak.

3. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 1. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
 2. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
 3. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).
- B. Line Test Pressure for Refrigerant R-407C:
 1. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
 2. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
 3. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).
- C. Line Test Pressure for Refrigerant R-410A:
 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).
- D. Do not use pre-charged refrigerant lines more than 50 feet in length.

2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88, Type K or L; or ASTM B280, Type ACR.
- B. Wrought-Copper Fittings and Unions: ASME B16.22.
- C. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- D. Flux: Stay-Silv white brazing flux by J.W. Harris Co or silver solder flux by Handy & Harmon.
- E. Brazing Filler Metals: AWS A5.8.
 1. Copper to Copper Connections:
 - a. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
 - b. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
 2. Copper to Brass or Copper to Steel Connections
 - a. AWS Classification BAg-5 Silver (45% silver)
 3. Do not use rods containing Cadmium.

- F. Manufacturers: Mueller Streamline, Nibco, Grinnell, Elkhart, or equal.

2.03 FLEXIBLE CONNECTORS

- A. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
- B. End Connections: Socket ends.
- C. Offset Performance: Capable of minimum 3/4 inch (20 mm) misalignment in minimum 7 inch (180 mm) long assembly.
- D. Working Pressure Rating: Factory test at minimum 450 psig (3100 kPa).
- E. Maximum Operating Temperature: 250°F (121°C).
- F. Manufacturers: Metraflex #RAF or equal.

2.04 COPPER PRESS-CONNECT TYPE FITTINGS AND JOINTS – IN JURISDICTIONS WHERE 2018 MECHANICAL CODE IS ADOPTED **THE UMC ANSWERS & ANALYSIS COMMITTEE ANSWERED AS FOLLOWS:** THESE FITTINGS DO NOT MEET THE CRITERIA SET FORTH IN CHAPTER 11 SECTION 1109.2 OF THE 2015 UNIFORM MECHANICAL CODE FOR USE WITH APPROVED REFRIGERANTS. ZOOMLOCK FITTINGS ARE NOT OF THE FLARED OR SWAGELOK TYPE, THEY ARE CLASSIFIED AS PRESSED FITTINGS WHICH ARE NOT LISTED AS AN APPROVED JOINING METHOD FOR REFRIGERATION PIPING IN THE UMC AND IMC UP THROUGH 2015 CODE CYCLE. THE FITTINGS ARE LISTED BY AN APPROVED LISTING AGENCY TO THE UL 207 STANDARD, WHICH IS A STANDARD FOR REFRIGERANT-CONTAINING COMPONENTS AND ACCESSORIES. MOST PRESS-TYPE COPPER FITTINGS ARE LISTED TO ASME B16.51 OR IAPMO PS-117.)

- A. Flame free press fittings are allowed as a contractor option, however confirm compliance with allowable refrigerant usage, and local building codes authority having jurisdiction.
- B. Product Characteristics (minimum):
 1. Continuous Operating Temperature: 250°F (121°C).
 2. O-Ring Temperature Rating: -40 to 300°F (-40 to 149°C).
 3. Maximum Rated Pressure: 700 psi (49 bar).
 4. Minimum Burst Pressure: 2,100 psi (145 bar).
 5. Vacuum Pressure Capability: 20 micron.
 6. Maximum Leak Rate: 0.1 oz Helium per year.
 7. Vibration Resistance: Conforms to UL 109.
- C. Klauke 15 kN Compatible Jaws: Hard Drawn Copper: 1/4" to 7/8" Type ACR, M, L, Type K up to 7/8". Soft (Annealed) Copper: 1/4" to 1-1/8" Type ACR, L, Type K up to 7/8".
- D. Klauke 19 kN Jaws and RIDGID Compatible Jaws: Hard Drawn Copper: 1/4" to 1-3/8" Type ACR, M, L, K. Soft (Annealed) Copper: 1/4" to 1-3/8" Type ACR, L, K.
- E. Tubing: The installer shall confirm the copper tubing conforms to ASTM B280, ASTM B88, or EN 12735-1.
- F. Fitting Body: Conform to ASTM-B75 or ASTM-B743.

- G. Fitting Sealing O-Rings: HNBR. These shall be factory installed only.
- H. Compatible ODM Fittings: Material conform to C12200 copper per ASTM B280 or Cu-DHP CW024A per BS EN 12735-1.
- I. Threaded Schraeder Valve Access Fittings: Schraeder style valve material and threads conform to SAE J513.
- J. Threaded Fittings: Flare nuts conform to SAE J513 & SAE J533.
- K. Manufacturers: Parker Sporlan #Zoomlock or approved equal.

2.05 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.
- B. Wrought-Steel Fittings: ASTM A234, for welded joints.
- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Flanged Unions:
 - 1. Body: Forged-steel flanges for NPS 1" to NPS 1-1/2" (DN 25 to DN 40) and ductile iron for NPS 2" to NPS 3" (DN 50 to DN 80). Apply rust-resistant finish at factory.
 - 2. Gasket: Fiber asbestos free.
 - 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 - 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 - 5. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch (180-mm) long assembly.
 - 6. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
 - 7. Maximum Operating Temperature: 330°F (165 C).
- F. Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket.
 - 2. End Connections:
 - a. NPS 2" (DN 50) and Smaller: With threaded-end connections.
 - b. NPS 2-1/2" (DN 65) and Larger: With flanged-end connections.
 - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch (180-mm) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 - 5. Maximum Operating Temperature: 250°F (121°C).

G. Manufacturers:

1. Anaconda "Vibration Eliminators" by Anamet.
2. Vibration Absorber Model VAF by Packless Industries.
3. Vibration Absorbers by Superior Valve Co.
4. Style "BF" Spring-flex refrigerant connectors by Vibration Mountings.
5. Or equal.

2.06 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 F (135 C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 F (135 C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 F (135 C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
 2. Core: Removable ball-type check valve with stainless-steel spring.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig (3450 kPa).
 6. Manufacturers: Apollo Valves (Conbraco), Henry, Mueller, Superior, Virginia, or equal.
- E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24/115/208-volt ac coil as required.
 6. Working Pressure Rating: 400 psig (2760 kPa).
 7. Maximum Operating Temperature: 240 F (116 C).
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig (2760 kPa).
 6. Maximum Operating Temperature: 240 F (116 C).
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Reverse-flow option (for heat-pump applications).
 6. End Connections: Socket, flare, or threaded union.
 7. Manufacturers: Alco, Henry, Mueller, Parker, Singer, Sporlan, or equal.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

5. Seat: Polytetrafluoroethylene.
 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter and 24/115/208-volt AC coil as required.
 7. End Connections: Socket.
 8. Throttling Range: Maximum 5 psig (34 kPa).
 9. Working Pressure Rating: 500 psig (3450 kPa).
 10. Maximum Operating Temperature: 240 F (116 C).
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig (3450 kPa).
 5. Maximum Operating Temperature: 275 F (135 C).
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig (3450 kPa).
 6. Maximum Operating Temperature: 275 F (135 C).
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in parts per million (ppm).
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig (3450 kPa).
 7. Maximum Operating Temperature: 240 F (116 C).
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10-micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. End Connections: Socket.
 5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement for suction-line filter dryers.

6. Maximum Pressure Loss: **2 psig (14 kPa)**.
 7. Working Pressure Rating: 500 psig (3450 kPa).
 8. Maximum Operating Temperature: 240 F (116 C).
- M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10-micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. End Connections: Socket.
 5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 6. Maximum Pressure Loss: **2 psig (14 kPa)**.
 7. Working Pressure Rating: 500 psig (3450 kPa).
 8. Maximum Operating Temperature: 240 F (116 C).
 9. Manufacturers: Alco, Mueller, Parker, Sporlan, Virginia, or equal.
- N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig (3450 kPa).
 4. Maximum Operating Temperature: 275 F (135 C).
- O. Receivers: Comply with AHRI 495.
1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL for receivers larger than 6 inches (150 mm).
 2. Comply with UL 207; listed and labeled by an NRTL.
 3. Body: Welded steel with corrosion-resistant coating.
 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 5. End Connections: Socket or threaded.
 6. Working Pressure Rating: 500 psig (3450 kPa).
 7. Maximum Operating Temperature: 275 F (135 C).
- P. Liquid Accumulators: Comply with AHRI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig (3450 kPa).
 4. Maximum Operating Temperature: 275 F (135 C).
- Q. Sight Glass
1. Combination moisture and liquid indicator with protection cap.
 2. Sight glass shall be full line size.

3. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.
4. Manufacturers: Alco, Asco, Mueller, Parker, Sporlan, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide and install refrigerant piping, fittings, valves and devices as required by equipment manufacturer and as shown on the Drawings.
- B. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
 1. No soft solder (tin, lead, antimony) connections will be allowed in system.
 2. Braze valve, sight glass, and flexible connections.
 3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.
- C. Insulate all suction and hot gas lines. Insulate liquid lines where pipe may be in close contact to humans.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 1. Install valve so diaphragm case is warmer than bulb.
 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at refrigerant piping connection to all equipment (coils, condensers, and/or compressors) as required by the manufacturer and where necessary to prevent vibration from transferring into the building structure and to minimize vibration and audible noise in occupied spaces.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective chaseway where installed belowground.

- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Install sleeves and escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Steel pipe: Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
 - H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
 - I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 3.05 PRESS-FIT PIPING INSTALLATION-ZOOMLOCK (CONTRACTOR OPTION)
- A. Installers shall follow all installation steps per the Sporlan #Zoomlock installation instructions. This covers examination, preparation and installation.
 - B. Upon delivery to the jobsite, the installing contractor shall examine the copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes or cracks.
 - C. If any brazing is required, the installer shall follow the manufacturer guidelines.
 - D. Wrapping electrical tape over the end of a flare fitting can be used when placing foam insulation of a pipe to prevent tearing.
 - E. The installer shall not crimp Sporlan #Zoomlock fittings over flared style tubing (ODF). The installer can cut off the flare and crimp the Sporlan #Zoomlock fitting to the tube as long as there is a minimum of two inches of tube remaining.
 - F. Installer shall ensure piping is spaced such that the crimp gauge can be fit around the pipes to check for proper crimp.
 - G. The installer shall place Sporlan #Zoomlock fittings no closer than 1" apart.
 - H. The installer shall locate the copper tubing such that the crimp tool and jaws can fit around the fittings.
- 3.06 HANGERS AND SUPPORTS
- A. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
 2. Spring hangers to support vertical runs.
 3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - B. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. Up to NPS 5/8" (DN 18): Maximum span, 60" (1500 mm); minimum rod, 3/8" (9.5 mm).
 2. Greater than 5/8" up to NPS 1-1/8" (DN 25): Maximum span, 72" (1800 mm); minimum rod, 3/8" (9.5 mm).
 3. Greater than 1-1/8" up to NPS 2" (DN50): Maximum span, 96" (2400 mm); minimum rod, 3/8" (9.5 mm).
 4. NPS 2-1/2" (DN 65): Maximum span, 108" (2700 mm); minimum rod, 3/8" (9.5 mm).
 5. NPS 3" (DN 80): Maximum span, 10 feet (3 m); minimum rod, 3/8" (9.5 mm).
 6. NPS 4" (DN 100): Maximum span, 12 feet (3.7 m); minimum rod, 1/2" (13 mm).
- C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2" (DN 50): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
 2. NPS 2-1/2" (DN 65): Maximum span, 11 feet (3.4 m); minimum rod, 3/8 inch (9.5 mm).
 3. NPS 3" (DN 80): Maximum span, 12 feet (3.7 m); minimum rod, 3/8 inch (9.5 mm).
 4. NPS 4" (DN 100): Maximum span, 14 feet (4.3 m); minimum rod, 1/2 inch (13 mm).
- D. Support multifloor vertical runs at each floor.

3.07 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
 4. Prepare test and inspection reports.

3.08 SYSTEM CHARGING

- A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
 4. Charge system with a new filter-dryer core in charging line.

3.09 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

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SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 DESCRIPTION OF SCOPE

- A. Provide complete water treatment work required by this section as indicated on drawings and schedules and by requirements of this section, and includes necessary equipment, chemicals, and service for the following systems:
1. Cleaning solution for HVAC Piping Systems.
 2. Treatment of cooling tower condenser water systems-startup only.
 3. Treatment of cooling tower condenser water systems.
 4. Treatment of chilled water systems.
 5. Treatment of heating water systems.
 6. Treatment for steam systems.
 7. Treatment of process cooling water systems.
 8. Treatment of heat recovery loop piping systems.
 9. Treatment of solar water heating systems.
 10. Closed loop glycol solution charging and maintenance systems.
- B. Provide chemicals and service program for a period of one year from start-up date of equipment, including the following:
1. Initial water analysis and recommendations.
 2. Systems start-up assistance and supporting documentation.
 3. Training of operating personnel.
 4. Periodic field service and consultation for first year of operation.
 5. Customer report charts and log sheets.
 6. Laboratory technical assistance.

1.03 GENERAL PERFORMANCE REQUIREMENTS

- A. Water treatment systems for closed loop and open loop piping systems, including condenser water, chilled water, heating water and steam systems shall inhibit corrosion and scale to maximize efficiency and operating life of HVAC equipment.

- B. Water treatment systems for cooling towers shall also inhibit microbiological fouling.
- C. Water treatment shall be based on existing water quality, HVAC system materials and performance, and any local jurisdictional requirements.
- D. Water treatment services shall include water analysis; water quality goal definition; solid or liquid chemical products designed to treat specific water conditions; effective dosage calculations; equipment adjustment and maintenance. Services shall be provided by qualified water treatment professionals trained in solid chemical application.
- E. Water treatment equipment for delivery of solid or liquid chemicals shall deliver accurate dosages per professional water treatment service recommendations, and use equivalent or less energy than liquid chemical systems.

1.04 QUALITY ASSURANCE

- A. **Manufacturers and Representative Qualifications.** Firms regularly engaged in manufacture of water treatment equipment, chemical and service shall have been active in the field of industrial water treatment and whose products have been in satisfactory use in similar service for not less than 5 years, and shall have full-time service personnel located within 150 miles of the project site.
- B. **Codes and Standards:**
 - 1. **ASME Compliance:** Construct pressure service tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, provide stamp and certification.
 - 2. **UL Labels:** Provide water conditioners ancillary electrical components that have been listed and labeled by UL.
 - 3. **NEMA Standards:** Provide electrical controls and enclosures conforming to applicable standards of NEMA for environment where water conditioners are indicated.
 - 4. **Chemical Standards:** Provide only chemical products that are acceptable under state and local public health and pollution control regulations. All products shall have the necessary registrations and approvals. All biocides shall be registered with the company performing the service in the State where the project is located and the company shall have all necessary licenses.

1.05 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product including rated capacities of selected equipment clearly indicating water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.
- B. **Shop Drawings:** Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. **Wiring Diagrams:** Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. **Record Drawings:** At project closeout, submit record drawings of installed systems and products.

- E. Maintenance Data: Submit maintenance data and parts list for each item of equipment, control, and accessory; including “trouble-shooting” maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle water treatment materials and components carefully to prevent damage, breaking, denting and scoring to materials and equipment. Deliver packaged units in original crates. Do not install damaged water treatment materials and components; remove from site and replace with new.
- B. Store water treatment materials and components in an environment satisfactory to prevent their damage by the elements.

1.07 EXTENDED MAINTENANCE SERVICES

- A. Agreement to Maintain: Prior to time of final acceptance, submit four copies of “Agreement for Continued Service and Maintenance” for water treatment system, for Owner’s possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner. For the purposes of this section, the date of substantial completion shall begin on the date regular chemical treatment has commenced for the water systems.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating, chilled water, condenser water, dual-temperature water and glycol cooling, shall have the following water qualities:
 1. pH: Maintain a value within 9.0 to 10.5, or as required by equipment manufacturer.
 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm, or as required by equipment manufacturer.
 3. Boron: Maintain a value within 100 to 200 ppm, or as required by equipment manufacturer.
 4. Chemical Oxygen Demand (non-glycol systems): Maintain a maximum value of 100 ppm, or as required by equipment manufacturer.

5. Soluble Copper: Maintain a maximum value of 0.20 ppm, or as required by equipment manufacturer.
6. TSS: Maintain a maximum value of 10 ppm, or as required by equipment manufacturer.
7. Ammonia: Maintain a maximum value of 20 ppm, or as required by equipment manufacturer.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm, or as required by equipment manufacturer.
9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/mL.
 - e. Iron Bacteria: Maintain a maximum value of 0 organisms/mL.

2.02 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.
- B. Chemicals to be FDA approved and safe for use with direct steam injection humidification and for steam used in direct contact with food.

2.03 CHEMICAL POT (BYPASS) FEEDER FOR CLOSED LOOP SYSTEMS

- A. Refer to Section 23 21 13 Hydronic Piping, Valves and Specialties for bypass feeder requirements.

2.04 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter:
 1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
 2. Body: Bronze.
 3. Minimum Working-Pressure Rating: 150 psig.
 4. Maximum Pressure Loss at Design Flow: 3 psig.
 5. End Connections: Threaded.
 6. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250 Vac; and that will close at adjustable increments of total flow.
 7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Water Meter:
 1. AWWA C701, turbine-type, totalization meter.
 2. Body: Bronze.
 3. Minimum Working-Pressure Rating: 100 psig.

4. Maximum Pressure Loss at Design Flow: 3 psig.
5. End Connections: Threaded.
6. Control: Low-voltage signal capable of transmitting 1000 feet.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze or Epoxy-coated cast iron.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. End Connections: Flanged.
6. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250 Vac; and that will close at adjustable increments of total flow.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.

8. Internal adjustable hysteresis or deadband.
 9. Bleed Valves:
 - a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
 - b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.
- F. Biocide Feeder Timer:
1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
 2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
 3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Pre-bleed and bleed lockout timers.
 4. Solid-state alternator to enable use of two different formulations.
 5. 24-hour display of time of day.
 6. 14-day display of day of week.
 7. Battery backup so clock is not disturbed by power outages.
 8. Hand-off-auto switches for biocide pumps.
 9. Biocide A and Biocide B pump running indication.
- G. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 2. Molded cover with recess for mounting pump.
 3. Capacity: 30-gallon, minimum. Upsized as required by system volume.
- H. Chemical Solution Injection Pumps:
1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
 2. Adjustable flow rate.
 3. Metal and thermoplastic construction.
 4. Built-in relief valve.
 5. Fully enclosed, continuous-duty, single-phase motor.
 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269, Type 304. Stainless steel for steam boiler injection assemblies.
- J. Injection Assembly:
1. Quill: Minimum NPS 1/2" with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 2. Ball Valve: Three or two-piece, stainless steel; selected to fit quill.

3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200°F.

2.05 SYSTEMS FOR TREATMENT OF CLOSED LOOPS

A. Antifreeze Protection of Closed Loops.

1. Systems requiring an antifreeze solution are to be charged with propylene glycol.
 - a. Condenser or chilled water systems are to be charged with Dow Chemical Dowfrost propylene glycol or equal. The fluid is to be colorless and must be easily capable of being analyzed for concentration and inhibitor level. Solutions up to 80% to be non-flammable. Operating range to be -50F to 250 F.
 - b. Heating water systems requiring treatment are to use Dow Chemical Dowfrost HD propylene glycol with industrial corrosion inhibitors. Fluid to be dyed bright yellow to facilitate leak detection.
2. The water treatment company to provide an auto glycol feed unit for maintenance of charge subsequent to initial fill. The feed unit shall be mounted on a pre-painted steel stand with 50 gallon tank capacity. Unit shall be capable of discharge pressure of above systems design operational pressure. Discharge pump will be fit to unit in a prefabricated method delivering 1.5-3.5 GPM discharge rate.
3. The unit shall come with a pressure sensor, controller and remote alarm output which triggers feed in the event of pressure loss indicating water loss.
4. Manufacturers Advantage Controls, Neptune, JL Wingert. No acceptations.

B. Leak Alarm for Closed Loop:

1. Closed loop systems are to be equipped with a water meter on the makeup water connection. The meter supplied by the water treatment company will have the ability to send dry closure contact signals to the energy management system. Connections are to be coordinated between the mechanical contractor and the control contractor. Alarm outputs will be programmed by the control contractor and mechanical joint work for water leak detection. Manufacturers: SeaMetrics #M Series or equal.

2.06 NON-CHEMICAL TREATMENT FOR COOLING TOWER AND FLUID COOLER SYSTEMS:

- A. Non-chemical device technology shall be considered where the make-up water supply contains less than 25 ppm SiO₂ and Ca levels are less than 25 ppm. The non-chemical system shall include all necessary components to provide a fully functional system to control scale, corrosion, and biological contamination.
- B. Refer to Section 23 25 01 Non-Chemical HVAC Water Treatment for options.

2.07 ANTIFREEZE SYSTEMS FOR TREATMENT OF CLOSED LOOPS IN FREEZING ENVIRONMENTS

A. Antifreeze Protection of Closed Loops.

1. Systems requiring an antifreeze solution are to be charged with propylene glycol.
 - a. Condenser or chilled water systems are to be charged with Dow Chemical Dowfrost propylene glycol or equal. The fluid is to be colorless and must be easily capable of being analyzed for concentration and inhibitor level. Solutions up to 80% to be non-flammable. Operating range to be -50F to 250 F.

- b. Heating water systems requiring treatment are to use Dow Chemical Dowfrost HD propylene glycol with industrial corrosion inhibitors. Fluid to be dyed bright yellow to facilitate leak detection.
 2. The water treatment company to provide an auto glycol feed unit for maintenance of charge subsequent to initial fill. The feed unit shall be mounted on a pre-painted steel stand with 50 gallon tank capacity. Unit shall be capable of discharge pressure of above systems design operational pressure. Discharge pump will be fit to unit in a prefabricated method delivering 1.5-3.5 GPM discharge rate.
 3. The unit shall come with a pressure sensor, controller and remote alarm output which triggers feed in the event of pressure loss indicating water loss.
 4. Manufacturers Advantage Controls, Neptune, JL Wingert, or equal.
 - B. Leak Alarm for Closed Loop:
 1. Closed loop systems are to be equipped with a water meter on the makeup water connection. The meter supplied by the water treatment company will have the ability to send dry closure contact signals to the energy management system. Connections are to be coordinated between the mechanical contractor and the control contractor. Alarm outputs will be programmed by the control contractor and mechanical joint work for water leak detection. Manufacturers: SeaMetrics #M Series or equal.
- 2.08 CHEMICAL TREATMENT FOR OPEN CONDENSING WATER/COOLING TOWER SYSTEM
(NOTE TO EDITOR: DELETE IF USING NON-CHEMICAL WATER TREATMENT SYSTEM)
- A. Subject to compliance with requirements, provide products by US Water Services, Chem Pro Lab, San Joaquin Chemicals, Garratt-Callahan, Chemcoa Nalco, ITOH2 Industrial Treatment of Water, or equal.
 - B. General: Provide a prefabricated automatic control system to monitor and control cooling bleed by conductivity and feed of inhibitor based on impulse water meter signals. If pH and alkalinity of the makeup water source requires adjustment, a pH control system will be supplied.
 - C. Controller: The controller shall include all necessary control features in a single easily removable panel housed in a NEMA 12 enclosure. The system shall include all chemical injection fittings, chemical feed pumps, solution line injector or corporation stops, solenoid bleed assembly of appropriate size and alternating biocide with bleed lock out feature. Controller to be UL approved. Manufacturers: Pulsafeeder, LMI, Lakewood Instruments, Hydro Systems Company, Accepta, Advantage Control or approved equal.
 1. Biocide Program Timers and Pumps: An internal program within the controller shall provide "day, hour and minute trip" to periodically feed biocide. During the feeding of the biocide, the bleed cycle shall be automatically locked out to permit retention of the biocide. A suitable chemical pump constructed of materials resistant to the biocides to be used shall be provided to inject the biocide into the third chemical injection tee. Pump must have sufficient capacity to inject the necessary dosage of biocide for 24 hours operation within a one-hour time span. All oxidizing biocide feed pumps shall be of the peristaltic type. All oxidizing biocide injection feed locations shall be either directly into the cooling tower basin with a bulk-head fitting extending into and below the water line, or into the condenser water header with a corporation stop injection assembly to insure dissemination of material without causing damage to the pipe injection site. If Halogen chemistry is used, an ORP or Chlorine controller shall be supplied with all necessary sensors, pumps, and fittings.

2. Sensor shall be constructed of "O" ring sealed PVC with carbon electrodes. Temperature compensation over 32°F to 140°F shall be automatic to compensate for condenser water temperature changes. Sensor shall be easily removed from the flow cell via pin fasteners to facilitate cleaning.
3. Pressure rating shall be 150 psig. Conductivity calibration range shall cover 0.0 to 3,000 mmhos full scale. Front panel adjustable. Accuracy and repeatability 1%. Deadband 0.5% of full scale.
4. Auto-Off-Manual switch to be provided on front panel.
5. An alarm timer shall be provided to limit the time an inhibitor pump may be activated per bleed cycle when chemical inhibitor is fed proportional to bleed-off. The alarm timer range shall be 5 to 90 minutes and be front panel adjustable. The alarm timer shall:
 6. Disconnect the inhibitor feed pump.
 7. Activate an alarm light.
 8. Have no effect on the bleed cycle solenoid valve.
 9. Automatically reset after the conductivity is satisfied.
10. pH Control: Sensors shall be constructed of or enclosed in "O" ring sealed PVC housings and shall be easily removable from the flow cell for cleaning
 - a. Pressure rating shall be 150 psig.
 - b. The pH sensor shall be of the glass type in order to provide a linear display of pH.
 - c. The reference electrode shall be refillable and feature a visible KCL reservoir to permit easy viewing of the excess KCL level. A ceramic junction shall be used to ensure long electrode life.
 - d. pH calibration shall be front panel adjustable and have a fixed span of 4-9 pH for control and display.
 - 1) Control Accuracy: 0.0 pH units
 - 2) Deadband: 0.05 pH units
 - 3) Drift less than: 0.1 pH/month
 - e. An alarm timer shall be provided to limit the time an acid pump may pump continuously whether activated manually or automatically. The alarm timer range shall be 5 to 90 minutes and be front panel adjustable. In the alarm condition:
 - 1) The acid pump shall be disconnected.
 - 2) Activate the alarm light.
 - 3) Switch 115 VAC to a terminal for an external alarm.
 - 4) Automatically reset after the pH is satisfied or the output switched off.
 - f. "Low pH alarm timer override" shall function if the pH should drop to 6.5 (adjustable) or below within the system. In the alarm condition:
 - 1) The acid pump shall be disconnected.
 - 2) Activate the alarm light.
 - 3) Switch 115 VAC to a terminal for an external alarm.
 - 4) A combination flow switch, flow sight and back check valve shall be provided which will:
 - (a) Disconnect all outputs during a "no flow" condition.

- (b) Be magnetically operated and not utilize "through the pipe wall" levers or paddles that could be subject to fouling or sticking.
 - (c) Operate at 1.5 GPM minimum flow rate.
 - g. Display Lamps: All display lamps shall be solid state LEDs for longest life.
 - h. Display of pH and/or conductivity shall be as follows:
 - 1) Single meter readout of pH.
 - 2) Meter for pH and meter for conductivity.
 - 3) Chart recorder for pH, 60 day capacity, inkless recording type.
 - 4) Dual channel chart recorder for display of pH and conductivity, 60 day capacity, inkless recording type.
- D. Chemical Feed Pumps: Each pump shall be electronically controlled, positive displacement diaphragm type with variable stroke and speed, with the exception of the oxidizing biocide chemical feed pump. The only moving part in the drive mechanism shall be an electromagnet driven by an electronic pulsing circuit. No lubrication shall be required. The pump shall be fully adjustable with a maximum delivery of 24 GPD and a maximum working discharge pressure of 75 psig. For acid service, the pump head and fittings must be of PVC, the check balls ceramic, and the diaphragm and "O" rings of Viton. For non-acid service, the head may be Lucite and diaphragm of hypalon construction. All pumps to operate on 115 VAC. Biocide pump fittings, and head shall be polymoreslene. Diaphragm to be Teflon. A pre-plumbed chemical solution line assembly shall be PVC schedule 80 and be so constructed as to prevent excessive heat buildup due to chemical reaction with circulation water. Manufacturer: Liquid Metronics or equal. The assembly shall include:
 - 1. Acid injection tee.
 - 2. Inhibitor injection tee.
 - 3. 1/4" PVC ballcock valve installed in a tee to facilitate safe chemical pump priming and pressure relief.
 - 4. PVC double union shut-off valve 3/4".
 - 5. External chemical injection assembly with double union ball valve and brass gate valve shut-off.
- E. Solenoid Bleedoff Valve: Shall be pilot operated, cast-iron body with a brass top and rubber diaphragm to provide a slow closing action and have built in provisions for manual flow rate adjustment. Must be completely serviceable without removing it from the system line. Valve to be sized at minimum of one-half the diameter of tower makeup valve. Maximum working pressure 200 psig. Manufacturer: ASCO or equal.
- F. Water Meters: Contact pulse water meter with sealed pulse contact, sized for water makeup line and system requirements.
- G. Chemical Feed Piping: Schedule 80 PVC with solvent welded joints or polyethylene tubing with compression fittings.
- H. Chemical Tracking and Web-Based Monitoring Systems:
 - 1. Web-based monitoring interface and application for remote monitoring, documentation and optional remote control of chemical dosing. Manufacturers: Lakewood Instruments, Advantage Controls, or equal.

2. Used with solid chemicals containing a UV tracer dye. Manufacturers: APTech Group EnduroSolv brand solid chemicals with duroTrace UV additive, or equal.
3. UV probe and chemical analyzer with manual or automatic chemical feed adjustment capability.

I. Filtration

1. In applications where high cycles of concentration are being maintained, 7 to 10 cycles or more, provide a bag type, cartridge-type, or a sand filter system to remove suspended solids.
2. Refer to Section 23 26 13 Water Filtration for Open-Loop Hydronic Systems for requirements.

2.09 WATER TREATMENT EQUIPMENT – BOILERS: LOW- AND MEDIUM-TEMPERATURE BOILERS (< 350° F) OPERATING AT LOW PRESSURE (<15 PSI)

- A. All boilers shall be pre-equipped with surface blowdown line, manually controlled or automatically controlled based on water conductivity or boiler load.
- B. Chemical metering pumps
1. Positive displacement, diaphragm type pumps made of corrosion-resistant materials suitable for chemicals being used.
 2. Pumps shall have an adjustable flow rate, a minimum capacity of 1 gallon per hour (gph) and a minimum discharge rate of 1.5x line pressure at point of connection.
 3. Continuous duty totally enclosed drive. Solid-state electronic pulser fully encapsulated with quick-connect terminals. All electronics housed in chemical resistant enclosure.
 4. Automatic pressure relief when discharge pressure exceeds pump pressure by not more than 35%.
 5. Manufacturers: Pulsafeeder, LMI, Magnus, Prominent or equal.
- C. Chemical pump timers
1. Automatic reset type timers, activated by water meter, based on boiler feedwater use.
 2. 110/1/60 power connection.
- D. Water meters
1. Contact pulse water meter with sealed pulse contact, sized for feedwater line.
- E. Bleed blowdown solenoid valves
1. Boiler blowdown shall be provided by a motorized ball valve sized for blowdown requirement and specified for temperature and pressure requirement of the system and rated for use in a steam system.
 2. Brass body, actuator normally closed as required.
 3. 110/1/60 power connection.

2.10 WATER TREATMENT EQUIPMENT – BOILERS: STEAM BOILERS AND HIGH-TEMPERATURE BOILERS (< 350° F) AND ALL BOILERS OPERATING AT HIGH PRESSURE (>15 PSI)

- A. Feedwater for steam boilers high-temperature boilers operating at high-pressure (>15 psi) shall be softened. In addition, provide dealkalization and/or reverse osmosis as additional pretreatment.
 - B. All boilers shall be pre-equipped with surface blowdown line, manually controlled automatically controlled based on water conductivity boiler load.
 - C. Solid chemical dissolving units for boilers rated at under 100 HP
 - 1. One to four dissolving units for solid chemicals – sulfite or nitrite, scale inhibitor, caustic and amine- packaged in one-gallon recyclable plastic bottles, rated at 0.75 gpm at 40 psi water pressure. All-in-one solid chemical product is acceptable when recommended by the water treater.
 - 2. Electrical connections: none required.
 - 3. Manufacturers: Hydro systems company solid dissolvers, Advantage Controls SFS Series or approved equal.
 - D. Chemical metering pumps
 - 1. Positive displacement, diaphragm type pumps made of corrosion-resistant materials suitable for chemicals being used.
 - 2. Pumps shall have an adjustable flow rate, a minimum capacity of 1 gallon per hour (gph) and a minimum discharge rate of 1.5x line pressure at point of connection.
 - 3. Continuous duty totally enclosed drive. Solid-state electronic pulser fully encapsulated with quick-connect terminals. All electronics housed in chemical resistant enclosure.
 - 4. Automatic pressure relief when discharge pressure exceeds pump pressure by not more than 35%.
 - 5. Manufacturers: Pulsafeeder, Lmi, Magnus, Prominent or equal.
 - E. Chemical pump timers
 - 1. Automatic reset type timers, activated by water meter, based on boiler makeup water use.
 - 2. 110/1/60 power connection.
 - F. Water meters
 - 1. Contact pulse water meter with sealed pulse contact, sized for feedwater line.
 - G. Bleed blowdown valves rated for steam boilers.
 - 1. Valve for boiler blowdown shall be a motorized ball valve sized for blowdown requirement and specified for temperature and pressure requirement of the system.
 - 2. Brass body, actuator normally closed as required.
 - 3. 110/1/60 power connection.
- 2.11 CHEMICAL TREATMENT TEST EQUIPMENT
- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
- 2.12 CORROSION TEST COUPON RACK

- A. Corrosion Test Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
 - 1. Two-station rack for closed-loop systems.
 - 2. Four-station rack for open-loop systems.

2.13 STAINLESS-STEEL PIPES AND FITTINGS

- A. Stainless-Steel Tubing: Comply with ASTM A269, Type 316.
- B. Stainless-Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A351/A351M, Type 316 stainless-steel body; ASTM A276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig (1725-kPa) steam working-pressure rating and 600-psig (4140-kPa) cold working-pressure rating.

PART 3 EXECUTION

3.01 CHEMICAL COMPATIBILITY

- A. The Water Treatment Contractor is responsible for determining the system material content and submitting chemicals compatible with each system's content. In the case of systems equipped with aluminum heat exchangers, non-Borate Nitrite inhibitors must be submitted. For closed chilled water systems in excess of 10,000 gallons, non-Nitrate inhibitors must be submitted if aluminum heat exchangers are in use.

3.02 FLUSHING AND CLEANING

- A. The Water Treatment Contractor shall be responsible for furnishing the cleaning material and supervising the chemical cleaning of the chilled water piping, process cooling water system, condenser water piping, heating piping, and heat recovery loop piping. See 232113 for flushing and cleaning method for HVAC piping.
- B. The system to be cleaned shall be filled with a solution of 10% by weight of a heavy duty alkaline liquid cleaner. The cleaner shall be capable of wetting and penetrating heavy soil deposits of oil or grease, and keeping these products in suspension, for removal through flushing the system to drain. Alkaline cleaners shall not be used for systems with galvanized components to assure no stripping of zinc coating.
- C. The cleaning solution shall be circulated for a minimum of 8 to 24 hours depending on the system water volume. At the end of the circulation period the system shall be flushed to sanitary sewer drain for an additional 8 to 24 hours and then refilled with fresh water, taking care to remove any entrapped air from the system.
- D. At the end of the cleaning period, the system shall be chemically treated as specified. In no case shall the system being cleaned be left in an untreated condition for more than 8 hours.
- E. At the conclusion of the cleaning operation, the Water Treatment Contractor shall certify in writing that the system was cleaned as specified.

3.03 TESTING

- A. Closed Systems:
 - 1. Provide a Nitrite "Drop Test" kit or other inhibitor test kit for determining the level of Nitrite or other approved inhibitor in the closed system.
- B. Open Systems:
 - 1. Provide the following test equipment and test kits:
 - a. One conductivity meter and three ranges covering 0 to 10,000 PPM/TDS and with automatic temperature compensation.
 - b. Provide one reagent-free, fluorescent-reading meter for determining the level of inhibitor being used in the cooling tower water. Provide a Phosphonate/Molybdate test kit with systems treated without the use of fluorescent.
 - c. One "Drop Test" for determining the chlorine level of the water in the cooling tower water.

3.04 COUPON RACKS

- A. Coupon Rack for Closed Systems:
 - 1. Install two coupon holders between the low and high pressure of the circulating pump. The coupon holders shall be isolated with shut off valves for removing and inspecting the coupons. When the system is ready for startup, the Water Treatment Contractor shall install two pre-weighted coupons, one copper, and the other steel in the above coupon holders, noting time and date. At the end of each 180-day period, the coupons shall be removed, noting the time and date, re-weighed, and inspected, with a report being sent to the General Contractor/Mechanical Contractor, for distribution to the Owner's Representative, showing the condition of the system being treated. Coupon racks shall be PVC Schedule 80 composition for all chilled water closed loop systems and black iron composition for a heating water closed loop systems.
- B. Coupon Rack for Open Systems:
 - 1. Install a minimum two station coupon rack, built to ASME specifications and as shown on the drawing, made from 3/4" PVC Schedule 80 pipe. The coupon holders shall consist of nylon screw and nut for holding the coupon, PVC water inlet ball shut off valves, 3/4" PVC pipe, and the coupon rack shall be pre-mounted on a galvanized steel channel support frame. When the system is ready for startup, the Water Treatment Contractor shall install three pre-weighted copper coupons in the above coupon holders, noting time and date. Coupon will be removed at the end of each 90-day period, noting time and date, reweighed, and inspected, with a report being sent to the General Contractor/Mechanical Contractor, for distribution to the Owner's Representative showing the condition of the system being treated.

3.05 INSTALLATION

- A. Coordination where installation of Water Treatment equipment in piping systems is required with the other work (plumbing and heating piping) as necessary to interface components of water treatment equipment. Provide installation instructions to those firms providing installation.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

2. Install pressure gauges, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions.

C. Closed System Treatment:

1. The Pot Feeder is to be installed between supply and return with shut off ball valves at the level of the Pot. A discharge line is to be plumbed to drain with a shutoff ball valve at the Pot. The pressure connection is to enter the bottom side orifice of the pot feeder. The suction system side will connect to the upper orifice to the pot feeder. The bottom orifice on the pot feeder shall be used for a ball valve connection as drain and piped to a sanitary drain. Observe manufacturer recommendations.
- 2.
3. Add corrosion inhibitor chemicals to each closed system. The type of inhibitor chemicals shall be as recommended by the Water Treatment Contractor for the intended system materials, operating temperatures and application. Non-Nitrate inhibitors must be used for all closed loop systems in excess of 10,000 gallons. No Nitrite borate inhibitor is allowed should aluminum be used in the heat exchanger.

D. Antifreeze Solution Treatment

1. Furnish and install a sufficient quantity of anti-freeze fluid into the piping systems, where required, to provide a 30-50 percent glycol/50 percent water solution by volume. Solution shall offer freeze protection determined by design engineer. Minimum 5 F+.
- 2.
3. Thoroughly clean the piping systems before installing glycol fluid per cleaning protocol listed in closed loop cleaning 23 25 00
- 4.
5. Water used for mixing with glycol on antifreeze treated systems: Water used for mix to have low levels (less than 25 ppm) of chloride and sulfate and have less than 50 ppm total Hardness (Ca++, Mg++). For filling systems that will contain a reservoir of the water/glycol fluid solution, either reverse osmosis treated or distilled water is recommended

E. Coordination of chemical system with service access:

1. In the event a cooling tower mechanical room is located in an area that is inaccessible for delivery of wet chemical drums, the water treatment contractor shall base their bid on a control, feed, and bleed system that uses solid chemical technology for both scale, corrosion control, and bacterial control.

- F. Provide full size shut-off ball valves and piping between tower sump filter and inlet/discharge side of pump. Tower filtration system filters shall be of the multi-media sand filter type for all open systems and closed loop systems in excess of 10,000 gallons. The multi-media sand filters shall be capable of filtering down to a minimum of 0.5 micron and shall automatically perform unit backwashes based on a programmed pressure differential set-point. Filters for closed loop systems less than 10,000 gallons in capacity shall be of the cartridge filter type and shall be capable of filtering down to a minimum of 1 micron. Cyclone or other separator type filtration systems shall not be accepted

3.06 INSPECTION

- A. Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.07 FIELD QUALITY CONTROL

- A. Following start-up sample water at one-week intervals for period of three (3) weeks and provide a test report on the conditions of the water. Subsequent visits shall be at a monthly frequency.

3.08 SYSTEM START-UP

- A. The Water Treatment Supplier shall put the system into operation and adjust as necessary for proper operation.
- B. The Water Treatment Supplier shall provide a written report to the Division 23 Contractor indicating that the start-up has been completed and that all Water Treatment Equipment is operating properly.

3.09 TESTING AND CLEANING

- A. Following start-up sample all treated water systems at one-week intervals for period of three (3) weeks and prepare certified test report for each system being treated. Subsequent visits shall be at a monthly frequency.
- B. Start-up test, and adjust water conditioners in presence of manufacturer's authorized representative. Operate units including regeneration, back washing, rinsing and flushing. Adjust unit to maintain required steady state effluent water quality.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.10 CLOSEOUT PROCEDURES

- A. Provide services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of water treatment systems.
 - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.
 - a. The water treatment vendor shall provide scheduled owner training on all equipment supplied including but not limited to theory, function, safety, testing equipment and recommended tests and logging protocol.
 - b. The water treatment vendor must have the ability to provide a central online data base that the vendor and owners rep have access to all data from control equipment and water use.
 - 2. Submit certified test reports to Engineer.
 - 3. Provide a water treatment service program for the installation and warranty period.
 - a. The supplier shall provide from qualified service representatives, 12 service visits, complete with reports at the following times:
 - 1) Visit one: Aid on installation, identification of installation points for equipment, and outline of program with contractor as needed
 - 2) Visit two: Inspection and testing of cleaned and drained piping, scheduling tentative date for start-up.
 - 3) Visit three: Start-up of system.

- 4) Visit 4-12: Training of operators, and beginning monthly service visits to total 12 visits over one year of operation. Each call shall include testing all systems, checking chemicals and equipment and completing field test reports. Troubleshooting and training of new operators is always included.
4. Provide sufficient supply of biocide and inhibitor for the cooling tower system during the warranty period.

END OF SECTION

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SECTION 23 31 13

AIR DISTRIBUTION

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:

1. Ductwork - Rigid, Flexible and Fabric.
2. Diffusers, Grilles, and Registers.
3. Ductwork Specialties.
4. Flexible Connections.
5. Sealants, Adhesives and Tapes.
6. Duct Access Panels and Doors.
7. Backdraft and Relief Dampers.
8. Constant Volume Regulator.
9. Variable Air Volume (VAV) Terminal Units.
10. Combination Fire and Smoke Dampers.
11. Fire Dampers.
12. Smoke Dampers.
13. Control Dampers.
14. Louvers.
15. Flashings.
16. Bird/Insect Screens.
17. Sound Traps.
18. Elevator Shaft Vents.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic Materials and Methods.
- B. Section 23 05 93 - Testing, Adjusting and Balancing.
- C. Section 23 07 13 - Duct Insulation.

D. Section 23 09 00 - Building Automation System (BAS) Control.

E. Division 26 - Electrical.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. ARI 885-98: Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets.
2. AMCA-210: Laboratory Methods of Testing Fans for Rating Purposes.
3. ANSI S12.23: Designation of Sound Power Emitted by Machinery and Equipment.
4. ASC-A7001: Standard for Duct Sealants.
5. ASHRAE Standard 130: Methods of Testing Air Terminal Units.
6. AHRI Standard 885: Procedures for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
7. NFPA 90A: Standards for the Installation of Air Conditioning and Ventilating Systems.
8. NFPA 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
9. American Society for Testing and Materials (ASTM): Manufacture and test in accordance with the ASTM Standards, including:
 - a. ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip. Type 304 or 304 stainless steel.
 - b. ASTM A525: Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) Hot-Dip Process. G60 and G90 zinc-coated.
 - c. ASTM A527/A527M: Standard Specification for Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
 - d. ASTM C920: Standard Specification for Elastomeric Joint Sealants.
10. Underwriters Laboratory (UL): Manufacture and test in accordance with the UL Standards, including:
 - a. 181: Standard for Factory-Made Air Ducts and Air Connectors.
 - b. 181A: Standard for Closure Systems for Use With Rigid Air Ducts.
 - c. 181B: Standard for Closure Systems for Use With Flexible Air Ducts and Air Connectors.
 - d. 268A: Standard for Smoke Detectors for Duct Application.
 - e. 555: Standard for Fire Dampers.
 - f. 555C: Standard for Ceiling Dampers.
 - g. 555S: Standard for Smoke Dampers.
 - h. 723: Standard for Test for Surface Burning Characteristics of Building Materials.
 - i. 2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

B. Provide and construct ductwork systems in conformance with the latest editions of the following documents:

1. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
 2. SMACNA HVAC Air Duct Leakage Test Manual.
 3. SMACNA HVAC Phenolic Duct Construction Standards.
 4. SMACNA - Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" w.g. positive pressure or below -5" w.g. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards.
 5. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter.
 6. ASHRAE Fundamentals Handbook "Duct Design" chapter.
- C. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.
1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.
 2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.
- D. All ductwork and equipment shall be seismically supported and braced to meet or exceed the minimum requirements of "SMACNA Seismic Restraint Manual-Guidelines for Mechanical Systems" and local building code requirements.
- E. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenum shall be noncombustible or have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method or UL 723. All materials installed within a plenum shall meet these requirements or have a safety data sheet available to indicate that materials are non-combustible. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Discrete plumbing, mechanical, and electrical products that are located in a plenum and have exposed combustible material shall be in accordance with UL 2043.
- 1.05 DEFINITIONS
- A. Class 0: Factory-made air ducts and connectors, compliant with ANSI/UL 181, having a surface burning characteristic of zero. Typically constructed of semi-rigid corrugated aluminum. This does not include sheet metal ductwork constructed per SMACNA Standards.
 - B. Class 1: Factory-made air ducts and connectors, compliant with ANSI/UL 181, having a flame spread index of not over 25 and a smoke developed index of not more than 50. Typically constructed of flexible ductwork, rigid fiberglass ductwork and plastic ductwork. This does not include sheet metal ductwork constructed per SMACNA Standards.
 - C. Flexible Air Duct (Factory-Made): Class 0 or Class 1 air ducts tested in accordance with 15 tests per ANSI/UL 181 and installed in conformance with the conditions of the listing and NFPA 90A/90B. Flexible ducts shall not be installed to serve more than two stories and shall not penetrate a fire-resistance rated assembly or construction. Maximum lengths of flexible ductwork shall not exceed lengths identified in this section or as limited by the AHJ, whichever is shorter.

- D. Flexible Duct Connector (Factory-Made): Class 0 or Class 1 connectors tested in accordance with 12 of 15 tests per ANSI/UL 181 and installed in conformance with the conditions of the listing and NFPA 90A/90B. Connectors include, but are not limited to, short flexible connections between air handlers and ductwork systems, uninsulated transition fittings, specialty shapes for diffuser connections, etc. Connectors shall not penetrate a wall, floor, or ceiling. Maximum lengths of flexible ductwork shall not exceed five foot (5') lengths or as limited by the AHJ, whichever is shorter.

1.06 SUBMITTALS

- A. Prior to construction, submit for approval on all materials and equipment:
1. Ductwork - Rigid, Flexible and Fabric.
 2. Ductwork Specialties.
 3. Flexible Connections.
 4. Sealants, Adhesives and Tapes.
 5. Flashings.
 6. Bird/Insect Screens.
 7. Duct Access Panels and Doors.
 8. Backdraft Dampers.
 9. Control Dampers.
 10. Diffusers, Grilles, and Registers.
 11. Fire/Smoke Dampers - Schedule of selected dampers must include the location, nominal size, free area velocity, and static pressure drop at free area velocity for each damper.
 12. Sound Traps.
 13. VAV Boxes.
 14. SMACNA "HVAC Duct Construction Standards - Metal and Flexible".
- B. Shop Drawings: Provide shop drawings of sheet metal ductwork and plenums as follows:
1. Draw to a scale not less than 1/8" to one foot, with sheet sizes equal to Contract Drawings.
 2. Show duct sizes, where possible use even duct sizes.
 3. Show fitting details.
 4. Show coordination with lighting fixtures, fire dampers, fire/smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.
- C. Shop Drawings: Provide shop drawings for field erected mechanical equipment:
1. Draw to a scale of 1/2" to one foot, with sheet sizes equal to Contract Drawings.
 2. Show plan, sections, elevations and details of all joints and enclosures.
 3. Detail access doors and hardware.
 4. Detail coil, damper, humidifier, filter and fan installations.
 5. Show access space for electrical components that are part of the equipment provided and/or installed such as power and control panels on humidifiers. This shall be coordinated with Division 26 and NEC.

- D. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system furnished on the project include:
1. System name.
 2. Duct material.
 3. Duct gauge.
 4. SMACNA rectangular reinforcement number.
 5. SMACNA intermediate reinforcement number.
 6. SMACNA transverse reinforcement number.
 7. Rod diameter and type.
 8. Sealant type.
 9. Attachment method.
 10. Duct system design pressure.
- E. Construction IAQ Management Plan: Collaborate with the general contractor to submit and implement an IAQ Management Plan for the construction process meeting the requirements of the SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ Management Plan should address how compliance has been achieved in these required five areas as follows:
1. HVAC Protection
 - a. Shutdown of return side of existing HVAC system in areas affected by heavy construction.
 - b. Provision of temporary filters if existing or new systems must remain operational during construction.
 - c. Close supply, return and exhaust dampers and seal duct openings in areas subject to construction dust.
 2. Source Control
 - a. How will reduction of contaminants be reduced at the source?
 - b. What steps will be taken to employ low emitting products and sealants.
 - c. How will air handling equipment be cycled off when not needed?
 3. Pathway Interruption
 - a. Describe how the construction space will be ventilated as required to dilute contaminants.
 - b. Describe how occupied spaces adjacent to construction areas will be kept at positive pressure relative to spaces under construction.
 4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
 - a. Reduction of dust generated by work will be suppressed.
 - b. Maintaining a frequent cleaning frequency for dust and particulates.
 - c. Remove spills or excess applications of solvent-containing products as soon as possible.

- d. Remove accumulated water and keep work areas as dry as possible.
 - e. Protect insulation materials from exposure to moisture.
5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.
- F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.
- G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.
- H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
- I. At the discretion of the specifier, sheet metal gauges and reinforcing may be checked at various times to verify all duct construction is compliant.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
 - B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.
- 1.08 WARRANTY
- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
 - B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 DUCTWORK

- A. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Nucor or equal.
- B. Duct dimensions indicated on drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.
- C. Ducts shall be constructed of material gauges and reinforcement Class per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the code or standard. Refer to Part III - Execution for matrix of pressure and leakage requirements.
- D. Ductwork gauge shall not be thinner than 26-gauge for all work.

2.02 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60 (Z180) for ductwork inside the building envelope in non-corrosive environments. G90 (Z275) for ductwork installed external to the building and may be installed inside the building as an alternate to G60.
- C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.03 DUCTWORK FABRICATION

- A. Rectangular Ducts
 - 1. Longitudinal Seams:
 - a. Grooved seam flat/pipe lock (L-3), standing seam (L-4), single corner seam (L-5) or butt/corner weld for +/- 10 in. w.g. service. Snaplock and button-lock (L-1 and L-2) type joints are only allowed when ductwork is installed inside the conditioned space and when duct static pressures are less than 2" w.c. (500Pa). Lateral Joints:
 - b. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure and sealed airtight. Flanged and gasketed joint fittings, such as Ductmate 25/35/45, Carlisle, MEZ Industries, or equal, are acceptable joint methods, but must be sealed as described previously. Transverse duct joints shall be constructed per Figure 1-4 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed for transverse duct joints. T-5 slip joints may be used at connections to fire and smoke dampers as breakaway connections. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2" static pressures.
 - c. Exposed Ductwork: All sealant or gaskets applied internally within joint.
 - d. Concealed Ductwork: Same as exposed ductwork, or sealant may be applied to the exterior side of joints.
 - e. Welded where required for leakproof and airtight operation and per code.

B. Round Ducts**1. Longitudinal Seams:**

- a. Spiral seam (RL-1), butt weld (RL-4), or grooved seam flat/pipe lock (RL-5) for +/- 10 in. w.g. service.

2. Lateral Joints:

- a. Exposed Ductwork: Beaded sleeve joint (RT-1), crimp joint bead (RT-5), or flange type joint. All joints secured with sheet metal screws. All sealant applied internally within joint.
- b. Concealed Ductwork: Same as exposed ductwork, or sealant may be applied to the exterior side of joints.
- c. Welded where required for leakproof and airtight operation.

C. Elbows

1. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces, or as shown. For rectangular ductwork provide single thickness turning vanes on all short rectangular elbows less than 25" wide or provide double thickness turning vanes for short rectangular elbows 25" wide and greater. Number of vanes per SMACNA. Elbows with square throat and radius heel are NOT allowed.

D. Transitions

1. Construct transitions to not exceed the slopes identified per SMACNA HVAC Duct Construction Standards-Metal and Flexible. Slopes shall generally be no greater than 15%, and no greater than 30% where shown on the drawings.

E. Branch Connections

1. Provide 45° entry boots or radius taps for rectangular duct take-offs. Provide conical, bellmouth or 45° lo-loss boot taps for round duct take-offs. Straight 90° taps and spin-in taps are not allowed, except where round take-off duct size equals height of branch duct size. Provide volume dampers at each duct take-off for balancing. Provide insulation guards at transitions to lined ductwork.

F. Manufactured Joints

1. 316 stainless steel adjustable clamps with gaskets for connecting welded laterals, branches, and Y fittings. Manufacturer: CECO Environmental #KB Duct or equal.

2.04 RECTANGULAR DUCTWORK

- A. Construct rectangular ductwork to meet all functional criteria defined in of the SMACNA HVAC Duct Construction Standards-Metal and Flexible. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted.

1. Listed manufactured ductwork system are allowed where they are installed per the manufacturer's installation instructions and meet or exceed the requirements of the design requirements.

2.05 ROUND AND OVAL DUCTWORK

- A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. Comply with SMACNA HVAC Duct Construction Standards-Metal and Flexible, based on indicated static-pressure class unless otherwise indicated. Longitudinal seams shall be spiral lock seams or continuous welded. Flat oval may be utilized in space-restricted areas. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations.
- B. Round or oval duct and fitting manufacturers:
1. McGill Airflow Corporation.
 2. Lindab.
 3. Semco.
 4. Sheet Metal Connectors.
 5. Spiral Manufacturing.
 6. Nordfab.
 7. Spiral Fittings.
 8. Or equal.
- C. Flat-Oval Ducts:
1. Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- D. Transverse Joints:
1. Fabricate according to SMACNA HVAC Duct Construction Standards-Metal and Flexible, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions. All transverse joints, including mechanical flange type fittings, to be externally sealed at all joints.
 2. Exception: internal manufactured single or dual EPDM rubber gasket fittings do not require external sealant.
 3. Transverse joints in ducts larger than 50" diameter require flanged joints.
 4. Lap or snap lock seams are not permitted for round ductwork of any size.
- E. Longitudinal Seams:
1. Select seam types and fabricate according to SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA HVAC Duct Construction Standards-Metal and Flexible. All longitudinal joints shall be sealed airtight with sealant or continuous welding.
 2. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 3. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- F. Tees and Laterals:

1. Select types and fabricate compliant with SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-5, "45 Degree Tees and Laterals", and Figure 3-6, "Conical Tees" and "45 Degree Boot Tees" for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions.
2. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted.

G. Elbows:

1. Any deviation from a straight run shall be made using a gored or welded elbows or stamped elbows. Normal 90-degree elbows may include 5-gore fittings and the radius of the elbow is 1.5 times the diameter of the fabric duct. All gores shall be continuous metal or use fully welded joints/seams. Die stamped sheet metal elbows shall be fully welded on the heel and throat by an automated welder. Flexible duct elbows or adjustable gore type elbows are not allowed.
2. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces with prior approval or where shown on the drawings.

2.06 DIFFUSERS, GRILLES AND REGISTERS

- A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer's representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution per the acoustical basis of design. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.
- B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper where individual duct mounted balancing dampers are not provided.
- C. Refer to schedule on drawings for sizes, capacities and patterns.
- D. Manufacturers: Titus, Krueger, Price, Nailor, or equal.

2.07 DUCTWORK SEALANT

- A. Duct tape, pressure sensitive type, is not allowed.
- B. Solvent-based and oil-based sealants are not allowed indoors.
- C. Seal all transverse joints, including mechanical joint flanges, similar to Ductmate, on all supply, return, exhaust, and outside air intake ducts.
- D. All sealant systems for outdoor application to be suitable for use in exposure to water, sunlight, temperatures extremes associated with project location.
- E. All sealant systems for indoor application to be meet VOC limits as specified in South Coast Air Quality Management District (SCAQMD) Rule #1168 limiting VOC's to 80 grams/liter for duct liner adhesives and 250 grams/liter for duct sealants.
- F. Indoor Application Water-Based Joint and Seam Sealant:

1. Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
 - a. Sealant shall be water based latex UL 181 B-M non-reinforced sealant.
 - b. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0.
 - c. Flexibility on 1/4" mandrel.
 - d. Freeze/thaw stability - 5 cycles.
 - e. Service temperature: -20°F to +200°F (-29°F to +93°C).
 - f. ASTM 5590; Resistance to mold, mildew and water.
 - g. Meet all SMACNA seal classes.
 - h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10" water gauge.
 2. Manufacturer: Carlisle (Hardcast) #Iron Grip 601 or #Flex-Grip 550 or #Spray-Seal, Ductmate #PROseal, Design Polymerics #DP1010 or #DP1020 or #DP 1010 Spray, or equal.
- G. Indoor Application Water-Based Joint and Seam Sealant with Extended Material Warranty:
1. Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
 - a. Sealant shall be water based latex UL 181 B-M non-reinforced sealant.
 - b. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0.
 - c. Flexibility on 1/4" mandrel.
 - d. Freeze/thaw stability - 5 cycles.
 - e. Service temperature: -20°F to +200°F (-29°F to +93°C).
 - f. ASTM 5590; Resistance to mold, mildew and water.
 - g. Meet all SMACNA seal classes.
 - h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10" water gauge.
 - i. Manufacturer: Carlisle (Hardcast) #Iron Grip 601 or #Flex-Grip 550 or #Spray-Seal and #Aluma-Grip AFT-701 rolled sealant, or equal.
 2. And, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed by a 30-mil rolled sealant. Rolled sealant shall be comprised of a 2-mil foil faced with 28 mils of butyl adhesive/sealant conforming to the product specifications. Rolled sealant shall have the following physical properties:
 - a. Peel Strength: 16 lbs. per linear inch.
 - b. Tensile strength: 955 psi
 - c. Elongation: 560%
 - d. Bonding time: Instant with full bond in 24 hours.
 - e. Resistance to mold, mildew and water.
 - f. Weather Resistance per ASTM G-53 @ 2000 hours QUV.
 - g. Service temperature: -20°F to +200°F (-29°F to +93°C).

- h. Surface burning characteristics: Flame spread/smoke developed rating of 20/40, tested in accordance with UL 723.
 - i. VOC: 0 g/l
 - j. Meet all SMACNA seal classes.
 - k. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, and 6" water gauge.
 - l. Manufacturer: Carlisle (Hardcast) #Aluma-Grip AFT-701 rolled sealant, or equal.
- H. Outdoor Application Two-Part Tape Sealing System:
- 1. Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal.
 - 2. Manufacturer: Carlisle (Hardcast) #Two Part II, McGill Uni-Cast, or equal.
- I. Outdoor Application Low VOC Solvent Based Joint and Seam Sealant:
- 1. Flexible, adhesive sealant, suitable for outdoor application on joints and seams.
 - a. Sealant shall be solvent based synthetic elastomeric. Water and UV resistant. Crack and peel resistant.
 - b. Compliant with ASMT E84 and UL 723. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0 after cured.
 - c. Freeze/thaw stability - 5 cycles.
 - d. Service temperature: -20°F to +190°F (-29°F to +88°C).
 - e. VOC: 44 g/l.
 - f. ASTM 5590 compliant for resistance to mold, mildew and water.
 - g. Meet all SMACNA seal classes.
 - h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10" water gauge.
 - 2. Manufacturer: Design Polymerics #DP1090 or equal.
- J. Rolled (Tape) Mastic Sealant for indoor and outdoor application on flat sheet metal duct joints. Aluminum substrate with modified butyl sealant. Compliant with UL 181B-FX. Rolled sealant shall have the following physical properties:
- a. Peel Strength: >10 lbs. per linear inch.
 - b. Bonding time: Instant tack with full bond in 24 hours.
 - c. Resistance to mold, mildew and water.
 - d. Weather Resistance per ASTM G-53 @ 2000 hours QUV.
 - e. Service temperature: -20°F to +180°F (-29°F to +82°C).
 - f. Surface burning characteristics: Flame spread/smoke developed rating of 5/25, tested in accordance with UL 723.
 - g. VOC: 0 g/l.
 - h. Meet all SMACNA seal classes.
 - i. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6" and 10" water gauge.
 - j. Roll width as required to maintain minimum 3/4" adhesion width on each side of joint.
 - k. City of Los Angeles RR#8069 approved.

- I. Manufacturer: Carlisle (Hardcast) #Foil-Grip 1404-181BFX rolled sealant, or equal.
- K. Manufacturers of duct sealant systems for various ductwork applications: Design Polymeric, Tremco, Dure Dyne, Carlisle Hardcast, Ductmate, Mon-Eco Industries, Sikaflex, and McGill AirSeal LLC.

2.08 FLEXIBLE DUCTWORK

- A. Flexible one-inch thick (minimum) insulated round ductwork, Class 0 or Class 1, may be utilized for final connections to each air outlet and inlet, unless shown otherwise on the plans. Duct shall have a minimum R-4.2 for ductwork enclosed in conditioned spaces and R-8.0 for ductwork installed in unconditioned spaces. Maximum length of flexible ductwork in each low pressure branch shall not exceed five (5') feet and maximum flexible connector lengths shall not exceed five (5') feet.
- B. All connections shall utilize welded conical tees, aluminum conical fitting, or manufacturer high efficiency branch take-offs. Spin-in type or other types of butt tees, bullhead tees or straight taps ARE NOT permitted. Manufacturers: Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STO, or equal.
- C. Dampers regulators shall include end bearings as manufactured by DuraDyne, Ventlok or equal.
- D. Flexible ductwork for low pressure systems with positive static pressure up to 2" w.g. positive pressure and negative pressured up to 1/2" w.g. suitable for both terminal unit connection and diffuser/grilles. Flexible ductwork fittings may be used at seismic expansion joints and to accommodate vertical drift between building levels. Fabrication shall include a multiple laminate of aluminized polyester/mylar, fiberglass insulation, and polyester, mechanically locked to galvanized steel helix without adhesives, exterior fiberglass insulation and fire retardant polyester/mylar outer jacket. Manufacturers: Casco #L-181M, Flexmaster #Type 5B, Thermaflex #M-KC or EverClean, or equal.
- E. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes up to 18 inches to match duct size.

2.09 PRE-INSULATED PHENOLIC FOAM DUCT SYSTEM FOR INDOOR CONDITIONED LOCATIONS

- A. General
 - 1. Ductwork System materials, including the panel, adhesive, tape, sealant, flanges and gasket to be certified by Underwriters' Laboratory standard as a Class 1 air duct (UL 181)
 - 2. The preinsulated panels shall be manufactured of CFC-free phenolic foam thermo-bonded on both sides to a factory applied aluminum foil facing. The standard panel is to be no less than 1.15" (30mm) in thickness with minimum R-6 insulating value. Increase thickness as necessary to meet requirements of local energy code.
 - 3. All fabricated duct segments and fittings shall be designed to meet or exceed the minimum requirements of the "SMACNA HVAC Phenolic Duct Construction Standards" latest edition.
 - 4. Duct sizes are limited to maximum 80" x 80" operating up to 4" w.g. positive or 3" w.g. negative pressure class.
- B. System

1. The panels used in the fabrication of the ductwork system shall Pal Phenolic Duct rigid phenolic insulation panels with a thermal conductivity of 0.1977 BTU-in/hr•ft² °F and a minimum compressive strength of 29 psi, as manufactured by Pal International.
2. Pal Phenolic Duct rigid phenolic insulation panels shall comprise a 3.4–3.75 pcf nominal density CFC/HCFC–free rigid Phenolic insulation core with zero Ozone Depletion Potential (ODP), autohesively bonded on both sides with 60-micron aluminum internal liner and a 200-micron aluminum external liner. Both liners are to be solid aluminum with no perforations.
3. All other components required for the fabrication of the system shall be from the Pal Phenolic Duct System guidelines including the sealant, contact adhesive, aluminum tape, self–adhesive gasket, ductwork reinforcements, closures, connectors and flanges.

C. Fire and Smoke Performance

1. The rigid phenolic insulation panels shall achieve the following fire and smoke performance requirements:
 - a. ASTM E 84–low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
 - b. UL 723 –low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
 - c. UL 181 – UL/ULC classification as a Class 1 Air Duct to NFPA Standards 90A & 90B.

D. Sealant Material

1. All internal seams must be fully sealed with an unbroken layer of Pal Phenolic sealant.
2. Each ductwork section must be duly connected with an inter-locking, double sealed jointing system. Sufficient sealant should be applied to each layer in order to seal the rigid phenolic insulation panels and ensure minimum air leakage.
3. Ductwork reinforcement, if necessary, shall be applied to protect against side deformation from both positive and negative pressure.
4. All external seams where two separate panels join must be tiger clipped, taped and jacketed in watershed fashion whenever possible to achieve a permanent bond with a smooth appearance.

E. Manufacturers: AQC Industries #PalDuct, KoolDuct or equal.

2.10 PRE-INSULATED DUCT SYSTEM FOR OUTDOOR AND UNCONDITIONED LOCATIONS

A. General

1. Pre-manufactured exterior ductwork to be a double layered duct system using the Pal Phenolic duct panels pre-fabricated and assembled into inter-locking sections. This as an alternate method to contractor fabricated double wall sheet metal ductwork with internal insulation.
2. All fabricated duct segments and fittings shall be designed in accordance with “SMACNA HVAC Phenolic Duct Construction Standards” latest edition.
3. Duct sizes are limited to maximum 80” x 80” operating up to 4” w.g. positive or 3” w.g. negative pressure class.

B. System

1. The panels used in the fabrication of the ductwork system shall Pal Phenolic Duct rigid phenolic insulation panels with a thermal conductivity of 0.1977 BTU-in/hr•ft² °F and a minimum compressive strength of 29 psi, as manufactured by Pal International.
2. Assembled panels shall be a minimum of 2" thick and minimum R-10 insulating value.
3. Pal Phenolic Duct rigid phenolic insulation panels shall comprise a 3.4–3.75 pcf nominal density CFC/HCFC–free rigid Phenolic insulation core with zero Ozone Depletion Potential (ODP), autohesively bonded on both sides with 60-micron aluminum internal liner and a 200-micron aluminum external liner. Both liners are to be solid aluminum with no perforations.
4. All other components required for the fabrication of the system shall be from the Pal Phenolic Duct System guidelines including the sealant, contact adhesive, aluminum tape, self–adhesive gasket, ductwork reinforcements, closures, connectors and flanges.
5. Exterior weatherproof cladding shall be a 5 ply, zero permeability vapor barrier, puncture resistant, tear resistant, flexible, and meet UL-1709.

C. Fire and Smoke Performance

1. The rigid phenolic insulation panels shall achieve the following fire and smoke performance requirements:
 - a. ASTM E 84–low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
 - b. UL 723 –low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
 - c. UL 181 – UL/ULC classification as a Class 1 Air Duct to NFPA Standards 90A & 90B.

D. Sealant Material

1. All internal seams must be fully sealed with an unbroken layer of Pal Phenolic sealant.
2. Each ductwork section must be duly connected with an inter-locking, double sealed jointing system. Sufficient sealant should be applied to each layer in order to seal the rigid phenolic insulation panels and ensure minimum air leakage.
3. Ductwork reinforcement, if necessary, shall be applied to protect against side deformation from both positive and negative pressure.
4. All external seams where two separate panels join must be tiger clipped, taped and jacketed in watershed fashion whenever possible to achieve a permanent bond with weather protection and a smooth appearance.

E. Manufacturers: AQC Industries #QDuct, KoolDuct or equal.

2.11 PLENUMS AND EQUIPMENT CASINGS

- A. Construct casings and plenums in conformance with SMACNA. Minimum Pressure Class: Unless otherwise indicated construct plenums and casings to withstand either a negative or positive static pressure of 4" w.g.
- B. Single-Wall: Provide single-wall, casings and plenums where indicated on the drawings.
 1. Construct in accordance with SMACNA Standards.
 2. Use steel-angle-reinforced standing-seam construction.
 3. Locate intermediate bracing angles bolted to the casing 24 inches on centers.

4. Construct for static pressure indicated or for the maximum fan static pressure whichever is less.
5. Bolt to 3" high concrete pads using 1-1/2" x 1-1/2" x 1/4" thick galvanized steel structural sections.

C. Double-Wall: Provide double-wall insulated ductwork where indicated on the drawings.

1. Construct in accordance with SMACNA Standards. Provide insulation thicknesses to meet or exceed the minimum required by local energy codes.
2. Provide 2" (minimum) thick prefabricated double wall insulated metal panel assemblies, with 16-gauge aluminum or 18-gauge minimum galvanized steel outer sheets.
3. Provide 22-gauge galvanized steel inner sheets to encapsulate the insulation.
4. Casings shall be fully metal enclosed, insulated with 2" thick (minimum) rigid fiberglass insulation and conforming to NFPA 90A, with maximum flame spread of 25 and maximum smoke developed of 50.
5. Field or factory fabricate to size and configuration indicated on the drawings, using field verified dimensions.
6. Provide coordinated shop drawings.
7. Reinforce spans 10' or greater with structural steel sections to yield maximum deflection 1/4" at minus 10" w.g. or plus 10" w.g. static pressure.
8. Provide openings and doors, all factory framed, and reinforced with 304 stainless steel structural sections.
9. Construct doors of same material as casings, of sizes and locations indicated on the drawings but not smaller than 18" by 54", and conforming to SMACNA.
10. Provide doors, hinges and hardware factory fabricated and mounted.
11. Door swings shall open against air pressure, with door latches operable from either side.
12. Provide door seals with neoprene gaskets, which have an airtight seal.
13. Provide each door with a 10" by 10" wire reinforced double pane window.
14. Bolt base channel to 3" high concrete pads.

2.12 DUCTWORK SPECIALTIES

- A. General: Where specifically called for, materials for use in fabricating ductwork specialties shall be identical to that used to fabricate ductwork. See drawings and Part 3, Execution for schedule.
- B. Flexible Connections (Indoor Applications):
1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
 2. Neoprene (polychloroprene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame. Hypalon, teflon or silicone coated fabrics may be acceptable.
 3. Shall be airtight, watertight and fire retardant.
 4. Minimum density of 30 oz. per sq. yard.
 5. Temperature range: -40°F to 200°F
 6. Neoprene-only connectors are not allowed due to non-compliant surface-burning characteristics.

7. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal up to maximum dimensions of 4" metal, 6" fabric, 4" metal as required by application.
 8. Manufacturers: Ventfabrics #Ventglas, Duro Dyne, Q Industries, Kinetics, Ductmate Proflex or Elgen.
- C. Flexible Connections (Outdoor Applications):
1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
 2. Hypalon (chlorosulfurated polyethylene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
 3. Shall be airtight, watertight and fire retardant. Resistant to sunlight, ozone and weather.
 4. Minimum density of 26 oz. per sq. yard.
 5. Temperature range: -50°F to 275°F
 6. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal up to maximum dimensions of 4" metal, 6" fabric, 4" metal as required by application.
 7. Provide flexible cloth insulating blanket to encase flexible connections to maintain ductwork insulation integrity as follows:
 - 1) Jacket shall be UV and ozone resistant with Velcro attachment.
 - 2) Service Operating Temperature: 0-350°F.
 - 3) Jacket and Liner: silicon or teflon impregnated fiberglass or mineral wool cloth.
 - 4) Insulation: Aerogel, 2" thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
 - 5) Fastening: 2" Nomex Velcro or 1" straps and stainless steel D-rings.
 - 6) Thread: Kevlar/stainless steel thread.
 - 7) Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, or equal.
 8. Manufacturers: Ventfabrics #Ventlon, Duro Dyne, Kinetics, Ductmate Proflex or Elgen.
- D. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabrics Inc., Ventlok operating hardware. For accessible dampers, provide #641 self-locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3"wg, provide #640 HiVel dial regulator and #609 HiVel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.
- E. Multi-louver Volume Dampers: 16-gauge galvanized steel frame. Opposed, 6" wide, 16-gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.
- F. Ducts Through Roof: Unsupported duct penetration through a roof, without roof curbs, shall be 16-gauge (minimum), flashed and counterflashed, and provided with storm collars to secure a watertight construction.

- G. Bird/Insect Screens: 19-gauge (0.91 mm) galvanized after weld wire mesh (minimum gauge), 1/2" x 1/2" openings (maximum) set in a galvanized steel frame. Or, 23-gauge (0.57 mm) galvanized after weld wire mesh (maximum gauge), 3/8" x 3/8" openings (minimum) set in a galvanized steel frame. Verify minimum requirements per local code for outdoor air intake and exhaust outlets.
- H. Seismic Duct Connector (Indoors): Provide flexible connector at penetrations between two structural elements where the structural design has designated allowable seismic or settlement movement. Flexible EPDM elastomeric fabric bonded to a 1/4" steel perimeter flange on each end. EPDM shall be rated for maximum temperature of 250°F and 3 psi maximum. Connector shall be rated to meet or exceed structural design requirements with a minimum of 3" for axial compression, 3" axial extension, and 3" lateral deflection. Manufacturers: Mercer Rubber Co #ME-3/MI-9-3, Mason Industries #MD-4/MI-9, Flexicraft, Garlock, Hyspan, or equal.
- I. Hanging Cables with Adjustable Fastener: Wire rope hangers for maximum point loads not exceeding 100 lbs. (45 Kg) for supporting rigid galvanized ductwork not exceeding 18" (450 mm) diameter, and suspended diffusers/grilles/terminal units. Alternate to metal strap options per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
1. Wire Rope: High tensile steel wire rope, to ASTM 1023/1023M, class A zinc coating; 7 by 7 or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi (1,770 N per sq. mm); lengths, diameters, and wire construction to accommodate design loads and as indicated on Construction Shop Drawings.
 2. Adjustable Fastener: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lbs. (45 kg) (maximum per hanger).
 3. Manufacturers: Gripple #Standard No. 2/3/4/5, Ductmate #Clutcher, or equal.

2.13 ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct." Access doors shall be insulated hollow core double construction. Access doors in exhaust ducts shall be of same, or heavier, gauge material as duct in which installed.
- B. Casing Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 9-16, "Casing Access Doors." Access doors shall be insulated hollow core double construction of same, or heavier, gauge material as duct in which installed.
- C. Minimum door size shall be 12" by 12" for simple manual access and up to 24" by 24" where personnel must pass through infrequently. Provide 20" x 54" (minimum) door for access to filters and more frequent maintenance.
- D. Maximum door leakage shall not exceed 10 cfm/sq.ft. at maximum operating pressure. Doors larger than four sq.ft. in area shall open against pressure.
- E. Doors:
1. Double wall, rectangular.

2. Galvanized sheet metal with insulation fill and gauge thickness as indicated for duct pressure class. Minimum 1" insulation thickness for doors up to 24" tall and 2" thick insulation for larger door assemblies as required per energy code. Insulation not required in exhaust duct access doors as allowed by local code.
3. Vision panel shall be provided on doors 24" x 60" and larger.
4. Fabricate doors airtight and suitable for duct pressure and air leakage class.
5. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets for doors up to 24" tall. For larger doors provide 1-1/2" by 1/8" flat stock or 14-gauge angle frame.
6. Gaskets: Closed cell neoprene rubber, 1" x 1/4" (minimum).
7. Access Door Manufacturers (Small Dimensions, Low Pressure Rating): CESCO, Pottorff, Ruskin, Vent Products, Air Balance, Ductmate Sandwich, United Enertech, or equal, as required by size and pressure application.

F. Hinges and Latches:

1. Access doors up to 14 by 14 inches (300 x 300 mm) square: Two hinges or continuous piano hinge and one sash lock. Doors shall not be removable.
2. Access doors up to 16 by 24 inches (400 by 600 mm) square: Two hinges or continuous piano hinge and two sash locks (minimum). Doors shall not be removable.
3. Access doors up to 24 by 48 inches (600 by 1200 mm): Three hinges or continuous piano hinge and two compression latches (minimum) with outside and inside handles.
4. Access doors larger than 24 by 48 inches (600 by 1200 mm): Four hinges or continuous piano hinge and two compression latches (minimum) with outside and inside handles.
5. Latch Manufacturer: Ventlok #100 Series hinges and latches on low pressure system doors up to 18" maximum dimension, #200 Series on larger low pressure system doors, #333 Series on high pressure systems with stops, or equal.

2.14 CONTROL DAMPERS

- A. General: Low leakage dampers shall be Class 1A with a maximum leakage rate of 3 cfm/ft² at 1.0 in wg pressure difference when tested to AMCA Standard 500.
- B. Damper Type One: Airfoil Low Leakage Dampers (Galvanized Steel or Aluminum)
1. Application: Commercial supply, return, and general exhaust air systems up to 3,000 fpm velocity. Damper shall be rated for -22°F to 122°F (-30°C to 50°C) minimum operating range.
 2. Frames to be 5" x 1"x 16-gauge galvanized steel hat-shaped channel or 5" x 1" x 0.125 anodized extruded aluminum hat channel with corner reinforcement.
 3. Blades: Airfoil shaped, single piece, 6" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum.
 - a. Action:
 - 1) Parallel blade for open and closed control, and economizer dampers.
 - 2) Opposed blade for modulating and air flow measurement control.
 4. Seals: Silicone rubber or EPDM blade and jam seals.
 5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.
 6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.

7. Linkage to be concealed in frame.
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Damper position indicator switch(es) as required by control sequence.
11. Manufacturer: Ruskin #CD60 or #CD50, Swartout, NCA PBD/OPD-AF-101, American Warming, Tamco, Air Balance, Greenheck, Pottorff, Nailor or equal.

C. Damper Type Two: Airfoil Low Leakage for Coastal and High Moisture Environments (Aluminum)

1. Application: Commercial supply, return, and general exhaust air systems where damper will be exposed to damp marine air and where velocity is less than 3,000 fpm. Damper shall be rated for -22°F to 122°F (-30°C to 50°C) minimum operating range.
2. Frame to be 5" x 1" x 0.125 anodized extruded aluminum hat channel with silicon side seals and corner reinforcement.
3. Blades: Airfoil shaped, single piece, 6" wide (maximum), 6063-T5 anodized aluminum.
 - a. Action:
 - 1) Parallel blade for open and closed control, and economizer dampers.
 - 2) Opposed blade for modulating and air flow measurement control.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 1/2" diameter steel, hex-shaped, mechanically attached to blade.
6. Bearings: Self-lubricating stainless steel sleeve or molded synthetic sleeve.
7. Linkage to be concealed in frame.
8. Stainless steel hardware.
9. Damper position indicator switch(es) as required by control sequence.
10. Manufacturer: Tamco #SW Series, Ruskin #CD50, Swartout, NCA, Pottorff, American Warming, Air Balance, Greenheck or equal.

D. Damper Type Three: Heavy Duty Fan Discharge Control

1. Application: Velocity over 3,000 fpm as fan outlet damper.
2. Frames to be 8" x 2" x 12-gauge steel channel (minimum).
3. Blades to be 8" wide (maximum), 0.080 thick extruded aluminum airfoil design.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 3/4" diameter steel, hex-shaped, mechanically attached to blade.
6. Bearings: Stainless steel sleeve type pressed into frame.
7. Linkage to be out of airstream with 10-gauge galvanized steel clevis type arms with crank lever operator.
8. Provide with mill finish on blades and frame.
9. Maximum temperature rating to be 300°F.
10. Manufacturer: Ruskin #CD102, Nailor, Swartout, Pottorff, American Warming, Air Balance, Greenheck or equal.

E. Damper Type Four: Low Leakage Airfoil Insulated Dampers

1. Application: Air handler intake and exhaust. Damper shall be rated for -25°F to 180°F (32°C to 83°C) minimum operating range.
2. Frames to be 5" x 1"x 16-gauge galvanized steel hat-shaped channel or 5" x 1" x 0.125 anodized extruded aluminum hat channel with corner reinforcement.
3. Blades: Insulated, single piece, 6" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum, R-3.3.
 - a. Action: Parallel blade for open and closed control.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.
6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.
7. Linkage to be concealed in frame.
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Damper position indicator switch(es) as required by control sequence.
11. Manufacturer: Ruskin #IL35, Greenheck, Pottorff, Tamco, or equal.

F. Damper Type Five: Ultra Low Leakage Airfoil, Double Row Dampers

1. Application: Natural ventilation wall inlets and outlets with parallel (double row) damper blades. Damper shall be rated for -72°F to 275°F (-58°C to 135°C) minimum operating range.
2. Frames to be 8" x 1" steel or aluminum channel thermally broken with insulation within frame channels.
3. Blades: Airfoil shaped, single piece, 4" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum.
 - a. Action: Parallel blade for open and closed control.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.
6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.
7. Linkage to be concealed in frame
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Damper position indicator switch(es) as required by control sequence.
11. Manufacturer: Ruskin #CD40x2, Greenheck, Pottorff, Tamco, or equal.

2.15 BACKDRAFT AND RELIEF DAMPERS

A. Light Duty Counterbalanced Backdraft Damper

1. Applications: Low pressure ductwork systems, including outside air intake and exhaust locations.
2. Frame: Extruded aluminum channel frame with flanges to match ductwork requirements.

3. Blades: Parallel blades, horizontal orientation, 0.025" (0.6 mm) minimum formed aluminum. Maximum 6" wide blades. Extruded vinyl blade seals mechanically attached to blade edge.
 4. Counterbalance: Adjustable steel weights mechanically attached to blade.
 5. Mounting: Vertically or horizontally oriented as shown on the drawings.
 6. Sized for maximum velocity of 1,500 fpm (7.6 m/s).
 7. Maximum back pressure of 2.0" w.g. (1.1 kPa).
 8. Maximum Pressure Drop Fully Open: 0.06" w.g. (15 Pa).
 9. Manufacturer: Ruskin #CBD2, Greenheck #WD Series, or equal.
- B. Heavy Duty Counterbalanced Backdraft Damper
1. Application: Medium pressure air ductwork and generator exhaust.
 2. Frame: Galvanized steel, 16-gauge (1.5 mm) wall thickness minimum with flanges to match ductwork requirements.
 3. Blades: Parallel blades, horizontal orientation, 0.05" (1.2 mm) minimum formed aluminum. Maximum 6" wide blades. Extruded vinyl blade seals mechanically attached to blade edge.
 4. Counterbalance: Adjustable steel weights mechanically attached to blade.
 5. Mounting: Vertically or horizontally oriented as shown on the drawings.
 6. Sized for maximum velocity of 2,500 fpm (12.7 m/s).
 7. Maximum back pressure of 4.5" w.g. (1.1 kPa).
 8. Maximum Pressure Drop Fully Open: 0.20" w.g. (50 Pa).
 9. Manufacturer: Ruskin #BD6, Greenheck #HB Series, Nailor #1380, or equal.
- C. Barometric Relief Damper
1. Applications: Gravity hood exhaust, room pressurization control and stairwell pressurization relief.
 2. Frame: Extruded aluminum channel frame, 0.090" (2.3 mm) wall thickness minimum with flanges to match ductwork requirements.
 3. Blades: Parallel blades, horizontal orientation, 0.063" (1.6 mm) minimum formed aluminum. Maximum 6" wide blades. Extruded vinyl blade seals mechanically attached to blade edge.
 4. Counterbalance: Adjustable on-blade counterweights for tuning of start-to-open and full open blade operation.
 5. Axle: 3/8" (9.5 mm) galvanized steel rod with roller bearings.
 6. Mounting: Vertically or horizontally oriented as shown on the drawings.
 7. Sized for maximum velocity of 1,000 fpm (5.1 m/s).
 8. Maximum back pressure of 2.0" w.g. (0.5 kPa).
 9. Start-Open Pressure: 0.05" w.g. (12.5 Pa).
 10. Manufacturer: Greenheck #BR-30 for vertical mounting, Greenheck #BD-10 for horizontal mounting, or equal.
- D. Round Counterbalanced Backdraft Damper

1. Dampers shall be of the two-blade design with separate axles. Blades shall be retained in closed position with tensioned spring and field adjustable for required opening pressure. Not allowed for installation in dryer exhaust, kitchen exhaust or bypass air applications.
2. Frame: 20-gauge (1.0 mm) minimum galvanized steel.
3. Blade: 0.016" thick (0.40 mm) minimum aluminum.
4. Blade Seals: Vinyl foam.
5. Axle: 3/16" (4.8 mm) minimum steel.
6. Maximum Velocity: 1,000 fpm (7.6 m/s).
7. Maximum Pressure Drop Fully Open: 0.06" w.g. (125 kPA).
8. Manufacturer: Ruskin #BDR2, Greenheck #WDR-53 or equal.

E. Light Duty Non-Counterbalanced Neoprene Backdraft Damper

1. Applications: Low pressure exhaust from small mechanical equipment less than 2,500 cfm.
2. Frame: 16-gauge galvanized steel with flanges to match ductwork requirements.
3. Blades: Neoprene coated fiberglass. Maximum 6" wide blades.
4. Mounting: Vertically or horizontally oriented as shown on the drawings.
5. Sized for maximum velocity of 1,000 fpm (5.1 m/s).
6. Manufacturer: Ruskin #NMW2 or equal.

2.16 LOUVERS

- A. Louvers are generally to be provided under Division 8 or as specified in the equipment schedules on the drawings. Where louvers are not covered on architectural plans and specifications, contractor is to provide louvers with the following minimum specifications:
1. Louvers to be 6" deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.
 2. Frames to be constructed of 6" deep channel, aluminum or galvanized steel.
 3. Provide with 1/2" x 1/2" aluminum mesh bird screen mounted on backside of louver.
 4. Finish/color per architect/engineer's review of manufacturers color chart or custom color matching if required.
 5. Manufacturer: Ruskin #ELF6375DX or equal.

2.17 DUCT SMOKE DETECTORS (DSD)

- A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Division 26 area wide detection system.
- B. Coordinate with Division 26 work and electrical installer for power to smoke detector. Detector shall be installed in the system in compliance with Chapter 6 of the Mechanical Code and NFPA-72. Provide 24-volt power supply option and/or 24-volt transformer as required to coordinate with Division 26.

- C. Coordinate with control installer to assure that detector shall shut down the air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct smoke detector shall be installed in the supply or return in compliance with the applicable mechanical or building code. Coordinate with Section 230900 and 230593 work.
- D. Provide additional duct smoke detectors per requirements of Section 6.4 of NFPA-90A. Provide one duct smoke detector at each story to the connection to a common supply and/or return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.
- E. Provide additional duct smoke detectors in high rise buildings and I-2 Occupancies per the Section 907.2 of the Building Code with duct smoke detectors in the main return and exhaust air plenums of each air-conditioning system having a capacity greater than 2,000 cfm.
- F. Manufacturer: System Sensor #D2 series or equal.

2.18 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

- A. General:
 - 1. Provide UL labeled 3 hour rated fire dampers at 3-hour and greater penetrations.
 - 2. Provide UL labeled 1-1/2 hour rated fire dampers at less than 3-hour penetrations.
 - 3. All dampers to be certified under the latest UL Standard. Certification based on former non-current standards is unacceptable.
 - 4. All damper installations to conform with NFPA 90A and manufacturer's installation instructions. Details on drawings are shown for reference only.
 - 5. Install in ducts passing through walls, floors, and ceilings as required by code. Refer to Architectural and Mechanical plans for damper locations.
 - 6. Provide fire, smoke and fire/smoke dampers in locations as required by local code and NFPA-90A and 92A.
 - 7. Provide sleeves, slip joints, retaining angles, duct access doors, ceiling access panels, etc., as required to check and service the fire dampers. Slip or break away joints are not allowed to be taped or sealed.
 - 8. Access doors shall be tight fitting hinged with operable cam latches. Removable doors are not allowed. Access shall not require the use of keys, tools or special knowledge. The access point shall permanently labeled with 1" (25 mm) high letters: "FIRE DAMPER", "SMOKE DAMPER", or "FIRE/SMOKE DAMPER".
 - 9. All dampers to be designed for use in dynamic systems.
 - 10. Dampers shall be rated for Leakage Class I. Leakage Class II may be used if damper size is smaller than available Leakage Class I dampers.
 - 11. Dampers shall be certified for use by State and local authorities.
 - 12. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error. Do not install actuators in area where moisture can penetrate actuator or where temperature exceeds 120°F.

13. All fire dampers shall be sized to provide equivalent free area through the damper equal to, or greater than, the free area of the connecting ductwork. Upsize fire dampers as required to minimize pressure drops. In no case is the damper pressure drop to exceed 0.20" w.g., but ideally less than 0.10" w.g. for low velocity dampers, as designed for total system static pressure allowance. Refer to submittal requirements in Part One of this section and requirements on the drawings.
- B. Radiation Ceiling Fire Dampers:
1. Bladed ceiling fire damper constructed and tested in conformance with UL-555C (dynamic rating).
 2. Fire damper shall have a fusible link that opens at 165°F (74°C) or 212°F (100°C) for high temperature duct applications. Installation shall be in accordance with damper manufacturer's instructions.
 3. Provide fire blanket where required to obtain listed fire rating.
 4. Manufacturers: Ruskin #CFD Series, Greenheck #CRD Series, or equal by Pottorff, Cesco, Nailor, or Air Balance.
- C. Dynamic Fire Dampers (FD) for use in Dynamic and Static Systems:
1. Curtain fire damper constructed and tested in conformance with UL-555C.
 2. Fire damper shall have a fusible link that opens at 165°F (74°C) or 212°F (100°C) for high temperature duct applications. Fire damper shall be equipped for vertical penetrations with manufacturer supplied sleeve. Installation shall be in accordance with damper manufacturer's instructions.
 3. Curtain damper shall not be located in air stream during system operation, Style B or C. Clear inside opening through fire damper is to match clear inside opening of duct. Fire dampers in lined ducts are to match size of sheet metal duct.
 4. Dynamic Closure Rating Velocity: 2000 fpm (minimum).
 5. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10" w.g. at full air flow.
 6. Pressure rating: 4" w.g.
 7. Manufacturers: Ruskin #DIBD Series, Greenheck #DFD Series, or equal by Pottorff, Air Balance, Nailor or CESCO.
- D. Combination Fire and Smoke Dampers (FSD):
1. Required Locations:
 - a. Install at ducted penetrations through rated fire barriers, fire walls, rated ceilings, rated corridor ceilings, shaft enclosures, and smoke barriers and partitions as defined on Architectural drawings and Chapter 7 of the Building Code.
 - b. Per NFPA-90A install smoke dampers or combination fire/smoke dampers in systems with a capacity greater than 15,000 cfm to isolate the air handling equipment from the remainder of the system on the building supply and return side. Air handling units located on the floor they serve and only serving that floor are exempt. Air handling units located on the roof and serving only the floor immediately below the roof shall be exempt.
 2. General Requirements:
 - a. Dampers shall be Low Leakage Class 1 in accordance with UL 555S.

- b. Dampers shall be provided as a manufactured UL listed device with electric actuator. Actuator shall be attached to sleeve outside of air stream.
 - c. Temperature Rating: 165°F (74°C) or 212°F (100°C) for high temperature duct applications.
 - d. Mounting: Vertical or horizontal
 - e. Frame: 5" wide by 16-gauge roll formed, galvanized steel hat-channel, minimum.
 - f. Sleeve: Minimum 20-gauge thickness and minimum 16" long.
 - g. Bearings: Stainless steel, permanently lubricated sleeve type.
 - h. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with building code requirements. All combination fire and smoke dampers shall automatically reset from closed to open position upon the reapplication of power to actuators, if temperature switch is not tripped.
 - i. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.
 - j. Voltage: Coordinate with Division 26 work and electrical installer for power to damper actuator. Provide 24 VAC, 120 VAC or 230 VAC power option to match power supply provided by Division 26. Prior to purchase and installation coordinate with Division 26 to align power requirements at no additional cost to Owner.
 - k. Electric Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.
 - 1) Actuator shall carry a manufacturer's 5-year warranty.
 - 2) Damper position shall fail closed on loss of power.
 - 3) Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
 - 4) Actuator shall have UL555S Listing by the damper manufacturer and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23 amps at 120-volt running, or 0.11 amps holding at 120-volt (27 VA and 10 VA respectively for 24-volt power) for 70 in.lbs. torque.
 - 5) Stall and instantaneous type actuators are not acceptable.
 - 6) Do not install in areas where moisture can penetrate damper or actuator, nor where actuator temperature exceeds 122°F (50°C).
 - 7) Manufacturer: Belimo #FS Series or equal by Siemens, Johnson Controls, or Honeywell.
3. Required Options:

- a. Provide open or closed indicator assembly consisting of a single pole, double throw switch used to indicate damper blade position. Include switch mounting bracket, crank arm, blade bracket and linkage from blade to the switch. Or, provide optional actuator end switches to indicate damper open and damper closed positions. Coordinate with fire alarm system and FireFighter's Smoke Control Panel for remote indication and damper override control.
 - b. Provide a damper mounted testing module to permit test cycling of the damper actuator assembly as required for start-up testing and maintenance.
 - c. Provide integral duct smoke detector and coordinate with Division 26 for area smoke detection and comply with NFPA-90A and NFPA-72. All wiring to be provided by Division 26 installers. In buildings not equipped with an approved fire alarm system the smoke detection activation shall cause a visual signal and audible signal in a normally occupied area and be identified as air duct detector trouble. For exposed wall applications provide matching wall grille to maintain appearance and fire rating.
 - e. Temperature limited override: Provide a two-temperature electronic high temperature limit. A primary sensor at 165°F (or higher temperature as dictated by AHJ or Building Code) can be bypassed by an external electrical signal allowing the damper to reopen and remain open until the temperature reaches the setting of the secondary sensor at 350°F at which point the damper is closed and remains closed. Both sensors are to be equipped with manual resets.
4. Low Velocity Applications (1500 fpm or below):
- a. Maximum Rate Velocity: 1500 fpm.
 - b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
 - c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10" w.g. at full air flow.
 - d. Pressure rating: 4" w.g.
 - e. Manufacturers: Ruskin #FSD37 or #FSD60 or #FSD60-3, Ruskin #FSDR25 or #FSDR60 round style, Greenheck #FSD-211 or #FSD-231 or #FSD-311 or #FSD-311M, or equal by Pottorff, Nailor, Cesco or Air Balance.
5. High Velocity Applications (Greater than 1500 fpm):
- a. Maximum Rate Velocity: 4000 fpm.
 - b. Style: True airfoil-shaped, extruded aluminum blades with silicone edge seals.
 - c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.20" w.g. at full air flow.
 - d. Pressure rating: 4" w.g.
 - e. Manufacturers: Ruskin #FSD60 or #FSD60-3, Greenheck #FSD-211 or #FSD-231 or #FSD-311 or #FSD-331, or equal by Pottorff, Nailor, Cesco or Air Balance.
6. Low and Medium Velocity Round Applications (3000 fpm or below):
- a. Maximum Rate Velocity: 3000 fpm.
 - b. Style: Two piece 14-gauge thickness galvanized steel with mechanically fastened silicone edge seals
 - c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.15" w.g. at full air flow.

- d. Pressure rating: 4" w.g.
 - e. Manufacturers: Ruskin #FSDR25 or #FSDR60, Greenheck #FSDR-511, or equal by Pottorff, Nailor, Cesco or Air Balance.
7. Corridor Ceiling Application:
- a. Maximum Rate Velocity: 1500 fpm.
 - b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
 - c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10" sp w.g. at full air flow.
 - d. Pressure rating: 4" w.g.
 - e. Manufacturers: Ruskin #FSD60-C, Greenheck #CFSD-211, or equal by Pottorff, Nailor, Cesco or Air Balance.
- E. Smoke Dampers (SD):
1. Required Locations:
- a. Install at rated smoke barriers and partitions as defined on Architectural drawings and Chapter 7 of the Building Code.
 - b. Per NFPA-90A install smoke dampers in systems with a capacity greater than 15,000 cfm to isolate the air handling equipment from the remainder of the system on the building supply and return side. Air handling units located on the floor they serve and only serving that floor are exempt. Air handling units located on the roof and serving only the floor immediately below the roof shall be exempt.
2. General Requirements:
- a. Dampers shall be Low Leakage Class 1 in accordance with UL 555S.
 - b. Dampers shall be provided as a manufactured UL listed device with electric actuator. Actuator shall be attached to sleeve outside of air stream.
 - c. Temperature Rating: 165°F (74°C) or 212°F (100°C) for high temperature duct applications.
 - d. Mounting: Vertical or horizontal
 - e. Frame: 5" wide by 16-gauge roll formed, galvanized steel hat-channel, minimum.
 - f. Sleeve: Minimum 20-gauge thickness and minimum 12" long.
 - g. Bearings: Stainless steel, permanently lubricated sleeve type.
 - h. Smoke damper shall be equipped for vertical wall penetrations with manufacturer supplied sleeve and fail closed on loss of power. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with building code requirements. All combination smoke and fire dampers shall automatically reset from closed to open position upon the reapplication of power to actuators, if temperature switch is not tripped.
 - i. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.

- j. Voltage: Coordinate with Division 26 work and electrical installer for power to damper actuator. Provide 24 VAC, 120 VAC or 230 VAC power option to match power supply provided by Division 26. Prior to purchase and installation coordinate with Division 26 to align power requirements at no additional cost to Owner.
- k. Electric Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.
 - 1) Actuator shall carry a manufacturer's 5-year warranty.
 - 2) Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
 - 3) Actuator shall have UL555S Listing by the damper manufacturer and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23 amps at 120-volt running, or 0.11 amps holding at 120-volt (27 VA and 10 VA respectively for 24-volt power) for 70 in-lb torque.
 - 4) Stall and instantaneous type actuators are not acceptable.
 - 5) Do not install in areas where moisture can penetrate damper or actuator nor where actuator temperature exceeds 122°F (50°C).
 - 6) Manufacturer: Belimo #FS Series or equal by Siemens, Johnson Controls, or Honeywell.
- 3. Required Options:
 - a. Provide open or closed indicator option assembly consisting of a single pole and a double throw switch used to indicate damper blade position. Output from switch to position indicator light (LED, provided by Division 26) is by automatic temperature control contractor. Include switch mounting bracket, crank arm, blade bracket and linkage from blade to the switch.
 - b. Provide a test module to permit test cycling of the damper/actuator in the field
 - c. Provide integral duct smoke detector or coordinate with Division 26 for area smoke detection. Division 26 to provide all wiring. For exposed wall applications provide matching wall grille to maintain appearance and fire rating.
- 4. Low Velocity Applications (1500 fpm or below):
 - a. Maximum Rate Velocity: 1500 fpm.
 - b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
 - c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10" sp w.g. at full air flow.
 - d. Pressure rating: 4" w.g.
 - e. Manufacturer: Ruskin #SD-37, Ruskin #SD-60, Greenheck #SMD-201, Pottorff #SD-141, Pottorff #SD-151, or equal by Nailor, Cesco or Air Balance.
- 5. High Velocity Applications (Greater than 1500 fpm):
 - a. Maximum Rate Velocity: 4000 fpm.
 - b. Style: True airfoil-shaped, extruded aluminum blades with silicone edge seals.

- c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.20" sp wg at full air flow.
- d. Pressure rating: 4" wg.
- e. Manufacturer: Ruskin #SD-50, Greenheck #SMD-401, or equal by Pottorff, Nailor, Cesco or Air Balance.

2.19 VARIABLE AIR VOLUME TERMINAL UNITS

- A. Furnish and install variable volume zone boxes of the sizes and capacities shown on the Drawings.
- B. The control assemblies shall be pressure independent and shall be able to be reset to any airflow between zero and maximum scheduled CFM. The valves shall be normally open. The differential static pressure of the basic assembly shall not exceed 0.25" w.g. for all sizes with inlet velocities of 2,000 fpm or less.
- C. The air valve shall be galvanized steel or die cast aluminum; damper shafts shall operate in rustproof Delrin or equal, self-lubricating bearings. The air valve shall seat against durable gaskets and not exceed a 2% leakage rate per ARI standards.
- D. The control device shall be designed to maintain consistent flow measurement regardless of inlet flow deflection. Angled duct inlets, at 90° or less to the control device, shall not alter the maximum or minimum factory setting by more than 10%. The assembly shall incorporate a multi-point averaging differential pressure sensor mounted on the inlet.
- E. The cabinet assemblies shall be contained in a 22-gauge (minimum) galvanized steel box.
- F. Cabinet shall be internally insulated with liner that prevents fibers from entering the air stream.
 - 1. Insulation liner shall be 3/4" thick (minimum) or greater. Refer to schedule on drawing for additional requirements that may be more restrictive.
 - 2. Insulation types include, but are not limited to, the following:
 - a. Fiberglass or mineral wool acoustical duct liner bonded with a bio based thermosetting resin mat fiber-free facing.
 - b. Fiberglass or mineral wool insulation with a foil or sheetmetal facing.
 - c. Elastomeric or polyimide foam insulation with acrylic polymer airstream coating.
 - d. Natural (denim or recycled) fiber with bio based thermosetting resin mat fiber-free facing, foil facing or sheetmetal facing.
 - 3. Refer to Section 23 07 13 - Duct Insulation for additional requirements.
 - 4. Comply with ASTM E84, ASTM C1071, UL 723, UL 181, NFPA 90A and 90B, and UL Greenguard Low VOC certified.
 - 5. K-value: 0.25 Btu□in./(hr□ft²□°F) at 75°F (maximum).
 - 6. Flame spread index: ASTM E84, less than 25.
 - 7. Smoke developed index: ASTM E84, less than 50.

- G. Fabricate and install 5 foot (minimum) acoustically lined sheet metal discharge plenum on all air terminal units. Refer to detail on drawings for more information. Discharge plenum shall be mounted downstream of reheat coils where applicable. Inside dimension of plenum shall be 2" larger in height and 4" larger in width than the outlet of the air terminal unit or reheat coil, whichever is greater. Refer to detail on plans for additional information. This is required for acoustic noise dissipation. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed 0.35" w.g. for a double row coil or 0.20" w.g. for a single row coil. Coil shall be pressure tested to 200 PSIG. Maximum water pressure drop shall be limited to 5 feet w.g. unless otherwise noted.
- H. Controls to be direct digital and connected to the BAS. Provide boxes without operator. Provide factory mounted low voltage transformer of sufficient capacity to power the DDC controls. Coordinate control with temperature Control Contractor. Provide factory mounted operator and thermostat control if not provided by Control Contractor.
- I. Manufacturer: Titus ESV-3000, Price SDV, Enviro-Tec SSD, or equal.

PART 3 EXECUTION

3.01 DUCTWORK GENERAL REQUIREMENTS

- A. Fabricate ducts with galvanized sheet steel, except as otherwise indicated and as follows:
1. All duct system appurtenances are to be the same material as ductwork including volume dampers and access panels.
 2. Where duct joints are not connected using flanges or manufactured assemblies, provide sheet-metal screws equally spaces around the joint or equivalent fastening method as required by mechanical code and SMACNA HVAC Duct Construction Standards-Metal and Flexible. Where sheet-metal screws are utilized provide a minimum of three screws on round ductwork and minimum four screws on rectangular ductwork. Maximum spacing between screws shall not be greater than 12" on center.
 3. Humidifier ductwork: Ductwork for humidifiers shall be constructed of 20-gauge stainless steel ductwork with longitudinal seam at top of horizontal runs and all joints sealed watertight. Duct length shall be as required by humidifier manufacturer, or as shown on drawings whichever is greater, to allow for full absorption of water vapor. This portion of duct shall include an integral drain pan and drain line connection.
 4. Shower Rooms: Exhaust ductwork serving shower rooms or other wet areas shall be constructed of stainless steel or aluminum. Where shower room exhaust ducts connect to a general exhaust riser, the non-ferrous ductwork with sealed joints need only extend to point of connection to the general exhaust riser.
 5. Environmental exhaust ductwork serving domestic clothes dryers shall be constructed of metal and shall have smooth interior surface. Provide backdraft damper at discharge to atmosphere.
 6. Underground Ducts:
 - a. Install per manufacturer's instructions.
 - b. Install ductwork when outdoor temperatures are no lower than 20°F and do not exceed 95°F.
 - c. Slope ducts at 1/8 inch per foot (minimum) to allow for drainage to an accessible low point for maintenance.

- d. All underground ductwork shall be pressure and leak tested prior to backfilling and prior to installation of concrete. Leak test report shall be submitted to Owner's Representative for review and approval.
 - e. Provide pea gravel or sand back fill all around ductwork.
7. Non-toxic and non-hazardous wet vapor exhaust, such as dishwasher, sterilizers, cart washers, and shower exhaust systems:
- a. Material: Type 304 or 316L stainless steel, minimum 24-gauge spiral or sheet metal ductwork with G90 zinc coating. Type 304 or 316L stainless steel fittings.
 - b. Joints: welded, or swaged lap-joint with silicon caulk and stainless steel sheet metal screws.
 - c. All accessories shall be stainless steel including dampers, damper hardware and turning vanes.
8. Hazardous/corrosive chemical exhaust, Radio-Isotope hood, and Bio-safety cabinet exhaust:
- a. Material: Type 316L stainless steel, minimum 18-gauge fully welded ductwork and fittings. Approved G90 galvanized steel may be used where required by local authority.
 - b. Joints: TIG welded. Weld may be either butt-weld or swaged joint with lap weld with lap running in direction of airflow. Welding rod shall be type 316L material. MIG welding technique not allowed. Inert gas purging inside ductwork not required.
 - c. All accessories shall be 316 stainless steel including dampers, air valves, damper hardware, etc.
 - d. Pressure testing: Refer to pressure classification and testing procedure table this specification section.
9. Chemical fume hood exhaust:
- a. Material: Type 316L stainless steel, minimum 18-gauge ductwork and fittings.
 - b. Joints: TIG welded. Weld may be either butt-weld or swaged joint with lap weld with lap running in direction of airflow. Welding rod shall be type 316L material. MIG welding technique not allowed. Inert gas purging inside ductwork not required.
 - c. Flanges: Manufactured 309 stainless steel clamp and frame.
 - d. All accessories shall be 316 stainless steel including dampers, air valves, damper hardware, etc.
 - e. Pressure testing: Refer to pressure classification and testing procedure table this specification section.
10. Perchloric Acid Fume Hood Exhaust:
- a. Material: Type 316L stainless steel, minimum 10-gauge fully welded ductwork and fittings.
 - b. Joints: TIG butt welded. Welding rod shall be type 316L material. MIG welding technique not allowed. Inert gas purging inside ductwork required to achieve a smooth and slag free interior joint bead
 - c. All accessories shall be 316 stainless steel.
 - d. Pressure testing: refer to pressure classification and testing procedure table this specification section.
11. Magnetically or Electrically sensitive rooms, including MRI rooms:

- a. All ductwork, fittings, grilles/diffuser, screws, etc, shall be constructed of aluminum in and around magnetically/electrically sensitive rooms. Refer to all DSA Submittal for location of these critical rooms.

3.02 DUCTWORK CONSTRUCTION AND SEALING CRITERIA

- A. Leakage classification of ductwork shall conform to the minimum requirements of Table 3.1 and Table 3.2 (see below) based on procedures of “SMACNA HVAC Duct Construction Standards- Metal and Flexible” and “SMACNA HVAC Air Duct Leakage Test Manual” as follows:

TABLE 3.1 DUCT LEAKAGE CLASSIFICATION			
DUCT WORKING PRESSURE CLASS	AIR PRESSURE LESS THAN +/- 0.5”WC	AIR PRESSURE +/-0.5” TO +/-2.99”	AIR PRESSURE +/-3” TO +/-10” WC
SMACNA Seal Class	C	B	A
Sealing Applicable	Transverse joints	Transverse joints and longitudinal seams	Transverse joints longitudinal seams and all duct wall penetrations
LEAKAGE CLASS			
Rectangular sheet metal SMACNA Leakage Class	6	6	4
Round sheet metal SMACNA Leakage Class	6	4	2
Note: Duct sealant ranges and classification are generally more restrictive than SMACNA guidelines.			

- B. Ductwork shall be constructed to SMACNA pressure class based on 150% of the maximum working pressure at connection to air handling unit, or better as specified herein. Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

TABLE 3.2				
DUCT CONSTRUCTION CLASSIFICATION				
DUCT SYSTEM	LOCATION	WORKING PRESSURE (ESP FROM SCHEDULE)	BUILD TO SMACNA PRESSURE CLASS	BUILD TO SMACNA SEAL CLASS
Outdoor air intake	From outdoor air intake to AHU	-1" wc	-2" wc	B
Low pressure supply air	Downstream of air terminal units to grilles, registers or diffusers.	+0.5"	+1" wc	B
Low pressure supply air	From AHU to grilles, registers or diffusers.	+0.5 wc	+1" wc	B
Low pressure return air	From return grilles to AHU	-0.5" wc	-1" wc	B
Transfer air	From grille to grille, or acoustic boots or "z" bends	-/+0.25" wc	-/+0.5" wc	C
Med pressure supply air	From AHU to air terminal units	+6" wc	+10" wc	A
Med pressure supply air	From AHU to air terminal units	+4" wc	+6" wc	A
Med pressure supply air	From AHU to air terminal units	+2" wc	+3" wc	A
Med pressure return air	From air terminal units to AHU	-3" wc	-4" wc	A
Med pressure return air	From air terminal units to AHU	-2" wc	-3" wc	B
Med pressure return air	From air terminal units to AHU	-1" wc	-2" wc	B

TABLE 3.2				
DUCT CONSTRUCTION CLASSIFICATION				
DUCT SYSTEM	LOCATION	WORKING PRESSURE (ESP FROM SCHEDULE)	BUILD TO SMACNA PRESSURE CLASS	BUILD TO SMACNA SEAL CLASS
Relief air	From AHU to discharge at outdoors	+1" wc	+2" wc	B
General exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
General exhaust	From exhaust fan to discharge at outdoors	+1" wc	+2" wc	B
Toilet/shower room exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
Toilet/shower room exhaust	From exhaust fan to discharge at outdoors	+1" wc	+2" wc	B
Dust collection exhaust	From floor machine tool to dust collector	-8" wc	-10 " wc	A, or welded. Refer to specification

3.03 DUCTWORK LEAKAGE TESTING

- A. Refer to Section 23 05 93 - Testing, Adjusting and Balancing for air leakage testing requirements and procedures.

3.04 DUCTWORK SPECIALTIES INSTALLATION

- A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.

1. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper only where individual duct mounted balancing dampers are specifically noted as not provided. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.
2. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.
3. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.
4. Provide access doors, as required, for access to valves, controllers, dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.
5. Volume Dampers: Provide manual volume dampers in all supply, return and exhaust branch and run-out ductwork to grilles, diffusers, registers, and other inlet and outlet openings to facilitate balancing of air distribution systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper regulator. Volume dampers must be installed immediately downstream of each duct takeoff.
6. Multi-Blade Control Dampers: Provide control dampers as shown on drawings. Coordinate with BAS system provider for control actuators.
7. Splitters and splitter dampers shall not be installed in medium or low pressure supply ductwork to VAV systems.
8. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.
9. Except where noted, vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers installed per UL tested assembly including sleeves and retaining angles. Provide additional fire dampers indicated on the Drawings and as otherwise required by the IBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.

10. For penetration of fire rated partitions which meet the IBC Chapter Seven requirements of non-Group H occupancy penetration of tenant separation and corridor walls in buildings with fire sprinklers provide metal sleeves as follows: A minimum 12 inch-long (0.30 m) by 0.060-inch-thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1-1/2" by 1-1/2" by 0.060-inch steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 screws. The annular space between the steel sleeve and wall opening shall be filled with rock wool batting on all sides.
- B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.
1. Maximum spacing between hangers shall not exceed ten (10) feet for rectangular sheet metal ductwork and twelve (12) feet for spiral round sheet metal ductwork. Provide hanger at each change in direction and at each branch takeoff. Refer to "SMACNA HVAC Duct Construction Standards Metal and Flexible" for additional requirements.
 2. Provide duct supports within two (2) feet of each: duct elbow; connection to flexible ductwork; connection to terminal units; connection to fan coil units; connection to exhaust fans, connection to air handling units, and fire and/or smoke dampers.
 3. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to IBC and Architectural and Structural Drawings for seismic requirements.
 4. Do not support ductwork from other ducts, pipes, fans or any other pieces of equipment.
 5. Powder driver fasteners shall not be used to support rectangular ducts larger than 40" maximum dimension. Powder driven fasteners shall not be allowed in existing facilities.
 6. Support round duct, larger than 36", shall have two hangers at each support point.
 7. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.
 8. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.
- C. Other:
1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing oilers as required. Mount all fans on vibration isolators as specified.
 2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When vapor barriers are specified, install continuous overall external surfaces of the entire system.
 3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, supply ducts may be sized at a maximum velocity of 1,500 fpm or 0.08" sp friction per 100 feet, whichever provides the larger duct, and return/exhaust/intake ducts may be sized at a maximum velocity of 1,000 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct. Refer to Basis of Design for further duct sizing criteria.

4. Humidifiers: Humidifier installation shall be approved by manufacturer and coordinated with all other systems. Condensate piping shall include p-traps as recommended by the humidifier manufacturer. Insulate exposed piping as required by the code
5. Exterior Ductwork: Ductwork located and installed outside the building envelope, on roof, grade or other location exposed to weather, shall be constructed and sealed airtight and watertight. The top of exterior ducts shall be crossbroken and sloped 1% towards edge of duct to eliminate any locations where rainwater can collect. Or, provide additional duct supports and mounting adjustments as necessary to prevent water retention on top of ductwork.
6. Double Wall Ductwork: Insulated ductwork located and installed outside the building envelope may be constructed of two layers of galvanized sheetmetal encapsulating the insulation layer. The inner duct shall be constructed as the main carrier duct with gauge and fabrication as required per the SMACNA Duct Construction Standards and minimum 24-gauge. The insulation layer shall be provided as required by the local energy code or Section 230713 Duct Insulation, whichever is greater. The outer sheetmetal layer shall be a non-pressurized layer, minimum 24-gauge, to encapsulate the insulation layer to prevent weather degradation and optimize the insulation effectiveness for the life of the building. The top layer shall be crossbroken and sloped 1% towards edge of duct to eliminate any locations where rainwater can collect. Or, provide additional duct supports and mounting adjustments as necessary to prevent water retention on top of ductwork.
7. Access Floor Diffusers: The mounting ring for floor mounted diffusers are to be affixed to the floor tiles using a clamp insert or other method approved for use with the floor diffuser.

3.05 FLEXIBLE DUCTWORK INSTALLATION

- A. Flexible insulated round ductwork connectors may be utilized where shown on the Drawings and for transitions between air handling equipment and rigid ductwork. A five (5) foot (maximum) length of flexible air duct shall be allowed to be used as an elbow at a terminal device or air outlet/inlet, unless shown otherwise on the Drawings. No intermediate joints are allowed. Seal each end using two wraps of tape listed in accordance with UL 181B and marked 181B-FX, followed by a mechanical stainless steel screw operated drawband. Plastic drawbands are not allowed. Support duct to maintain smooth shape without sagging. All connections shall utilize welded conical tees, aluminum conical fitting, Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STO. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Damper regulators shall include end bearings as manufactured by DuraDyne, Ventlok or equal.
- B. Flexible duct runouts to diffusers and grilles is limited to the following sizes:
 1. 6" diameter: Up to 100 cfm
 2. 8" diameter: Up to 200 cfm.
 3. 10" diameter: Up to 360 cfm.
 4. 12" diameter: Up to 600 cfm.
 5. 14" diameter: Up to 900 cfm.

3.06 EXPANSION JOINTS

- A. At a non-rated penetration through an expansion joint wall:
 1. Provide insulated flexible ductwork through expansion joint. Flexible connector shall be no longer than five feet between segments of rigidly attached ductwork.

- B. At a fire/smoke rated penetration through an expansion joint wall:
1. Provide required fire/smoke damper with sleeve through rated assembly as required by Building Code and manufacturer's instructions. Provide breakaway duct connections as required by manufacturer's listing. Ductwork bracing on either side of wall must not be rigid within ten feet of wall to allow for building movement. Seismic restraints must not be closer than ten feet of expansion joints on either side of wall. Following a building seismic/movement event the ductwork will need to be inspected and possibly reattached to the fire/smoke damper.

3.07 STAINLESS STEEL DUCTWORK

- A. For installations serving moisture, vapor, or fume exhaust.
1. For connections to hoods or equipment provide minimum 12" length flanged and bolted stainless steel spool piece connection.
 2. All fittings shall be long radius. Round elbows shall be minimum 5-gore.
 3. Slope horizontal ductwork back toward source connected equipment minimum 1% slope so that moisture and liquids may drain back toward equipment.
 4. Low point "traps" in the ductwork shall be fitted with a low point drain valve, 1/2" welded connection, stainless steel piping and valve.
 5. All welding to be completed by certified welders experienced in 316 stainless steel.

3.08 DUCTWORK SEALANT METHODS

- A. General
1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
 2. All installation shall be in accordance with manufacturer's published recommendations.
 3. Cleanliness:
 - a. Before installing sealant, Surface must be dry and be free of dirt, oil, grease, and loose or foreign matter that could impair adhesion wipe ductwork to a visibly clean condition.
 - b. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.
 - c. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.
 - d. Follow the Advanced Level requirements as found in the SMACNA Duct Cleanliness for New Construction Guidelines.
- B. Installation of Mastic/Sealant Duct System
1. One Part Sealant System:
 - a. Apply one-part sealant system at a 20 to 30 wet mil thickness with a brush, putty knife; caulk gun or spray to duct joints, fasteners and seams. Tool, if necessary, caulk bead with putty knife or brush. Let dry per manufacturer data sheet of a minimum of 48 hours.

2. Or, One Part Spray Applied Sealant System:
 - a. Use a manufacturer approved airless sprayer capable of application pressure up to 2,000 psi spraying through a minimum 0.111 tip. Apply in a smooth application perpendicular to the substrate at a rate of 20 to 30 wet mils to joints, seams and duct wall penetrations per manufacturer's technical data sheet. Let dry per manufacturer data sheet of a minimum of 48 hours.
- C. Installation of Mastic/Sealant Duct System with 10-Year Warranty
 1. Installation of Rolled Sealant Tape over Mastic/Sealant:
 - a. Cut desired length for each side of the ductwork; peel off release liner and center over joint, seam or penetration. The rolled sealant should completely cover the sealant. Use hand pressure to place the rolled sealant followed by a squeegee application. Lap tape end 2 inches (50 mm minimum). Squeegee rolled sealant to insure bond and complete adhesion to the duct. Instant adhesion requires precise positioning. Not re-positional. Four-Bolt flange requires applying corner pieces prior to applying the edge strips.
- D. Field Quality Control
 1. Allow duct sealant system to cure minimum 48 hours before pressure testing for the fluid applied Sealants. Rolled sealants can be tested immediately with duct leakage tester.
 2. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.
 3. Notify Owner's Representative a minimum of seven (7) calendar days in advance of leakage testing.
 4. Leaks identified during ductwork air leakage testing shall be repaired by:
 - a. Complete removal of the sealing materials.
 - b. Thorough cleaning of the joint surfaces.
 - c. Installation of multiple layers of sealing materials.
 5. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.

3.09 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.10 FIRE AND COMBINATION FIRE/SMOKE DAMPER INSTALLATION

- A. Install per manufacturer's and UL installation requirements.
- B. For buildings with no fire alarm system all fire/smoke dampers shall be interconnected with the HVAC unit's controls and duct smoke detectors. The detection of smoke at any fire/smoke damper shall stop for HVAC unit fans and close all fire/smoke dampers. A single test/reset station shall be capable of resetting all devices back to normal operation.
- C. Smoke and fire/smoke dampers shall close upon activation of a listed smoke detector or detectors installed in accordance with Chapter 7 of the Building Code. Other than in mechanical smoke control systems, smoke and fire/smoke dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate. Coordinate with electrical installer for all work associated with smoke and fire/smoke damper wiring and smoke detector initiation.

3.11 CONTROL DAMPER INSTALLATION

- A. Note that installation of control dampers is a part of the mechanical contractor's work regardless of whether they are specified in this section or as part of products to be selected by the Control Contractor.
- B. When electric actuators are provided, dampers shall be installed to allow direct over the shaft mounting of actuators. No connecting rods and stand off brackets shall be necessary.
- C. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error.
- D. Blades shall close completely. Leakage shall not exceed manufacturer's specifications at rated static.
- E. Structural support shall be provided as necessary for all multi-section dampers.
- F. Where blankoffs or structural supports obstruct duct or air passages, the decrease in free area shall not exceed 15% of the damper face area unless otherwise specified here or on plans.
- G. No individual damper section may exceed 20 sq. ft.
- H. Dampers shall be parallel blades style for outside air economizer to facilitate improved mixing of outside air and return air. Airflows shall be directed towards each other.
- I. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.
 - 1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.
 - 2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

3.12 SEISMIC REQUIREMENTS

- A. See Section 23 05 49 for specific requirements.

- B. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.
- C. The seismic calculations shall be the responsibility of contractor.
- D. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA-Seismic Restraint Manual: Guidelines for Mechanical Systems and ASCE/SEI 7.
 - 1. Space lateral supports a maximum of 40 feet (12 m) and longitudinal supports a maximum of 80 feet (24 m) on center.
 - 2. Brace each change of direction longer than 12 feet (3.7 m).
- E. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install cable restraints on ducts that are suspended with vibration isolators.
- H. Install seismic-restraint devices using methods approved by the AHJ.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- J. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.13 EQUIPMENT

- A. Install equipment as shown on plans and in accordance with manufacturer's installation recommendations.

3.14 SUPPLY DIFFUSER AND REGISTER LOCATIONS

- A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

3.15 PAINTING

- A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.
- B. Ductwork exposed on the roof or exterior to the building shall be painted. Coordinate with Division 9 for requirements.

3.16 FIELD QUALITY CONTROL

- A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.
- B. Ductwork Deflection Criteria:
 - 1. Maximum inward and/or outward deflection at sheet metal panels shall be 3/4" under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed 3/4".
 - 2. Maximum inward and/or outward deflection at sheet metal elbows and joints shall be 1/4" under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed 1/4".
- C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 23 05 93 - Testing, Adjusting and Balancing.

3.17 ADJUSTING AND CLEANING

- A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Comb all coil fins that may be bent. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.

3.18 DUCT SEALING ALTERNATIVE

- A. Occasionally a ducted system will experience leaks after the ductwork has been installed and sealed per one of the SMACNA duct sealant classifications. These leaks may not be identifiable until after ductwork has been installed and system air balancing and leakage testing has been engaged. At the contractor's option an alternative solution to sealing such leaks may include the use of a water based sealing agent that is introduced to the interior of the duct system.
 - 1. Manufacturer: AeroSeal LLC or approved equal. Application must be performed by manufacturer approved provider.
 - 2. Sealant must be UL 723 approved for smoke and flame spread.
 - 3. Sealant must be UL 181 approved for humidity, mold growth, temperature, erosion and puncture resistance.
- B. Duct Sealing Procedure:
 - 1. Preparation:
 - a. Inspect the entire duct shaft and horizontal plenums for major leakage sites (larger than 1/2" across).

- b. Mechanically clean duct shaft per NADCA (National Air Duct Cleaners Associations) standards if more than 1/8" of surface contaminants are visible on duct surfaces.
 - c. Repair all major leakage sites using mastic and fiberglass mesh tape per SMACNA standards.
 - d. Temporarily remove or protect all building controls and smoke detectors from aerosol particles as recommended by the Manufacturer.
 - e. Temporarily disable fire alarms and notify appropriate authorities.
 - f. Temporarily isolate air-moving equipment and block off air inlets and air outlets as recommended by the manufacturer.
 - g. Protect occupied spaces from aerosol particles as recommended by the Manufacturer.
 - h. Protect air-moving equipment, air inlets and outlets and other devices and appurtenances as recommended by the manufacturers.
2. Duct Sealing:
- a. Seal existing ductwork from the inside using automated aerosolized sealant injection as recommended by manufacturer or by manually caulking internally with sealant.
 - b. Sealant must cure within 2 hours with no odor or VOC off-gasing thereafter.
 - c. Sealant shall remain elastic (not harden rigidly) after curing.
 - d. Sealant shall be deposited substantially at areas of leakage only, and shall not coat interior duct walls, duct lining material, dampers, or turning vanes.
 - e. Seal all test holes using patching plates sealed with mastic.
 - f. Repair or replace insulation to match existing.
 - g. Seal all injection openings with duct access doors or replace ductwork to match existing.
3. Duct Reassembly and Cleanup:
- a. Reinstall building controls and smoke detectors.
 - b. Enable fire alarms and notify appropriate authorities.
 - c. Remove blocking, reinstall grills and registers, and enable air handling fans.
 - d. Cleanup sealant residue that may have adhered to surfaces in occupied areas as recommended by the Manufacturer.
 - e. All work shall be done in a substantial and workmanlike manner by factory-trained technicians.
4. Testing:
- a. Provide pre-sealing and post-sealing leakage profile reports indicating percentage reduction of duct leakage for both supply and return ductwork.
 - b. Retest ductwork and document compliance with air leakage requirements as identified in section 23 05 93 Testing, Adjusting and Balancing.
5. Warranty:

- a. The Contractor shall warrant that the aerosol sealant application will be free from defects for a period of 3 years from date of the sealing application. If defects should occur during this period, the Contractor shall repair or replace the defective duct seals, including the direct labor costs for performing the repair or replacement, at no additional cost to the Owner.

END OF SECTION

SECTION 23 34 00

FANS AND VENTS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
 - 1. Spun Aluminum and Steel Housed Centrifugal Exhaust Fans
 - a. General Duty Spun Aluminum Exhaust fan
 - b. Upblast Spun Aluminum Exhaust Fan for roof or sidewall mount
 - c. Upblast Spun Steel Exhaust Fan for high temperature kitchen exhaust
 - 2. Small Cabinet Fans (Ceiling Mounted and Inline)
 - 3. Housed Centrifugal Fans
 - a. Utility Set
 - 4. Tubular Fans
 - a. In-line tubular or square centrifugal fans.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods
- B. Section 23 05 93 - Testing, Adjusting and Balancing
- C. Section 23 07 13 - Duct Insulation
- D. Section 23 07 16 - Equipment Insulation
- E. Section 23 09 00 - Building Automation System (BAS) Controls
- F. Section 23 31 13 - Air Distribution
- G. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. **Certifications:** Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
- C. **Codes and Standards:** Provide air handling units conforming to the requirements of the latest addition of the following:
1. **Air Movement and Control Association (AMCA):**
 - a. 99 Standards Handbook
 - b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
 - c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
 - d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - e. 500 Test Method for Louvers, Dampers, and Shutters
 2. **American National Standards Institute (ANSI):**
 - a. 9 Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 Test Performance of Air Filter Units
 3. **Air-Conditioning, Heating and Refrigeration Institute (AHRI):**
 - a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
 - b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
 - c. 430 Central-Station Air-Handling Units
 - d. 440 Room Fan-Coil Air-Conditioners
 4. **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):**
 - a. 15 Safety Code for Mechanical Refrigeration
 5. **National Electrical Manufacturers Association (NEMA):** Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 6. **National Fire Protection Association (NFPA):** Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50.
 - a. 70 National Electrical Code
 - b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems
 7. **Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):** Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
 8. **Underwriters Laboratories, Inc. (UL):** Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4" per one foot. Include field fabricated mixing boxes, dampers and duct connections.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.08 SAFETY PROVISIONS

- A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens meeting OSHA requirements.

1.09 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL FAN REQUIREMENTS

- A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association (AMCA). All fan wheels shall be statically and dynamically balanced. Size, capacity and features as indicated on the Drawings. Provide extended bearing lubrication fittings where necessary to assure accessibility of all lubrication points.
- B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40°C above ambient temperature or electronically commutated (EC) motors. Belt drive assemblies, where applicable, shall be capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts.

- C. Accessories: Provide, as indicated on the Drawings and specified in other paragraphs of this Section, all related accessories to match the fan section, including access sections, diffusion sections, transition sections, flexible connections, vibration eliminators, and belt guards.
- D. Submissions: For shop drawings include complete dimensional and physical data, CFM, SP, HP, discharge arrangement, rotation, class, base details, and fan curves.

2.02 HOUSED CENTRIFUGAL EXHAUST FANS (ROOF MOUNTED DOWNBLAST TYPE)

- A. Manufacturer: Models as scheduled by Greenheck, Carnes, Cook, Penn, Twin City or equal. Size, capacity and features as indicated on the Drawings.
- B. Fan Housing:
 - 1. The fan housing shall consist of the motor cover, shroud, curb cap and lower windband and shall be constructed of heavy gauge aluminum. The housing shall have a rigid internal support structure and leakproof design. The shroud shall be one piece with a rolled bead for extra strength which directs the exhaust air downward. Birdscreen shall be provided between the fan housing and shroud.
- C. Fan Wheel:
 - 1. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced in accordance to ANSI/AMCA Standard 204.
- D. General:
 - 1. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
 - 2. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
 - 3. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment or external to the fan.
 - 4. Motors and drives shall be readily accessible for maintenance.
- E. Motors: Provide direct drive or belt drive as scheduled on the Drawings.
 - 1. Direct drive motors:
 - a. Motors shall be premium efficiency or ECM as scheduled on the Drawings.
 - b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors shall be readily accessible for maintenance.
 - c. All ECM motors shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.
 - 2. Belt drive motors:
 - a. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel.

- b. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L₁₀ life in excess of 100,000 hours or L₅₀ life of 500,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

2.03 HOUSED CENTRIFUGAL EXHAUST FANS (ROOF MOUNTED UPBLAST TYPE)

- A. Manufacturer: Models as scheduled by Greenheck, Carnes, Cook, Penn, Twin City or equal. Size, capacity and features as indicated on the Drawings.
- B. Fan Housing:
 1. Leakproof fan housing shall consist of the motor cover, shroud, curb cap and one-piece windband and shall be constructed of heavy gauge aluminum. The housing shall have a rigid internal support structure and leakproof design. The shroud shall be one piece with a rolled bead for extra strength which directs the exhaust air upward. Birdscreen shall be provided between the fan housing and shroud.
 2. The windband shall be welded to the one-piece curb cap and on all sizes with UL/CUL-762.
- C. Fan Wheel:
 1. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced in accordance to ANSI/AMCA Standard 204.
- D. General:
 1. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring. A NEMA 3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment.
 2. Fan shall bear the AMCA Certified Ratings Seal for sound and air performance. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
 3. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment or external to the fan.
 4. Motors and drives shall be readily accessible for maintenance.
- E. Motors: Provide direct drive or belt drive as scheduled on the Drawings.
 1. Direct drive motors:
 - a. Motors shall be premium efficiency or ECM as scheduled on the Drawings.
 - b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors shall be readily accessible for maintenance.
 - c. All ECM motors shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.

2. Belt drive motors:
 - a. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel.
 - b. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L_{10} life in excess of 100,000 hours or L_{50} life of 500,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. Third pulley to be included for ease of adjusting drive belt tension and to enhance belt life and compliant with smoke control applications.

F. Smoke Control Exhaust Option:

1. Provide three belt drives be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
2. Fans shall be listed by Underwriters Laboratory for UL/cUL 705 for electrical components and UL/cUL Listed for Emergency Smoke Control Systems 500°F (260°C) for 4 hours and 1,000°F (538°C) for 15 minutes.

2.04 SMALL CABINET FANS (CEILING MOUNTED AND INLINE CABINET)

A. Ceiling mounted exhaust fans:

1. Manufacturer: Greenheck, Panasonic, Cook, Penn, Carnes, Twin City, Air King or equal.
2. General: Provide centrifugal direct drive type ceiling exhaust fan. The fan wheel(s) shall be of the forward curved centrifugal type and dynamically balanced.
3. Noise Data: Provide sone or octave band noise values at the required air delivery.
 - a. 0.3 sones at 80 cfm to 112 cfm
4. Fan Housing: The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2 inch acoustical insulation. The outlet duct collar shall include a backdraft damper on all sizes and shall be spring loaded on larger units above 200 cfm.
 - a. Integral backdraft damper shall be totally chatterproof with no metal-to-metal contact.
 - b. Entire fan, motor and wheel assembly shall be easily removable without disturbing the housing.
 - c. Outlet shall be adaptable for horizontal or vertical discharge.
5. Motor speeds shall not exceed 1100 RPM and all fan motors shall be suitably grounded and mounted on rubber-in-shear vibration isolators.
6. Grille: For 300 cfm and smaller fans the grille shall be constructed of high impact polystyrene and for larger sizes the grille shall be constructed of aluminum. Grilles shall be non-yellowing.
7. The access for wiring shall be external. The motor disconnect shall be internal and of the plug in type. The motor shall be mounted on vibration isolators.
8. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cUL Listed.

9. Provide the fan with the following required additional features:
 - a. Dual Speed operation integrated with both a humidistat and motion sensor to trigger high speed operation.
 - b. Single Speed operation integrated with humidistat and motion sensor to trigger operation of fan.
 - c. Remote wall mounted time switch, Intermatic Model E1210 with 10/20/30/60-minute digital push-buttons.
 - d. UL263/UL555C housing and damper assembly for installation in rated wood frame construction.

2.05 HOUSED CENTRIFUGAL FANS

A. Utility Set

1. Manufacturer: Trane, Loren Cook, Carnes, Industrial Air, Peerless-Winsmith, Penn, Aerovent, Twin City, or approved equal.
2. Direct Drive Utility Fans:
 - a. Supply, exhaust or return air fans shall be of the direct drive utility fan type, in AMCA Arrangement 4 with a single width, single inlet housing, in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge galvanized steel with lock formed seams permitting no air leakage. The housing shall be easily rotated in the field to any of the eight standard discharge positions. Housing supports shall be constructed of heavy gauge galvanized steel to minimize vibration and rigidly support the motor and wheel.
 - b. The fan wheel shall be of the forward curved or backward inclined type and shall be constructed of heavy gauge aluminum. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency. Motors shall be heavy duty ball bearing type matched to the fan load and furnished at the specified voltage, phase and enclosure.
3. Belt Drive Utility Fans:
 - a. Supply, exhaust and return air fans shall be of the belt driven utility fan type in AMCA Arrangement 10 with a single width, single inlet housing, in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge steel with air tightlock formed seams. The housing shall be easily rotated in the field to any of the eight standard discharge positions. Housing and bearing supports shall be constructed of welded steel members to prevent vibration and to rigidly support the shaft and bearings.
 - b. Fan wheels shall be of the forward curved type, constructed of heavy gauge steel with uniform stamped steel blades. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency.
 - c. Motors shall be heavy duty, ball bearing type, matched to the fan load and furnished at the specified voltage, phase and enclosure. The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours of maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

4. All fans shall bear the AMCA Certified Ratings Seal for air performance.

2.06 IN-LINE OR TUBULAR FANS

A. Inline Tubular or Square Centrifugal Fans

1. Manufacturer: Greenheck, Carnes, Cook, Penn, Twin City or approved equal.
2. Drive:
 - a. Belt Drive: Duct mounted supply, exhaust or return fans shall be of the centrifugal belt driven in-line type.
 - b. Direct Drive: Duct mounted supply, exhaust or return fans shall be of the centrifugal, direct driven in-line type.
3. Housing: The fan housing shall be of the square or cylindrical design as scheduled, constructed of heavy gauge galvanized steel or aluminum and shall include duct mounting collars. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.
4. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
5. Motors shall be heavy-duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Fan motor shall be premium efficiency, open drip-proof foot mounted, continuous duty and suitable for operation in either vertical or horizontal or angular position. Provide VFD compatible motors where indicated on the drawings.
6. Motors and Drive Access:
 - a. Belt Driven: Motor and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life at 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% if driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
 - b. Direct Drive: Motors shall be readily accessible for maintenance.
 - 1) Variable speed capability: For all direct drive fans with motors through $\frac{3}{4}$ " hp, the fan shall be equipped with a DC electronic commutation type motor (ECM). Motor shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.
7. A NEMA 1 disconnect switch shall be provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring shall be provided from motor to the handy box.
8. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance. The fan manufacturer must furnish published sound power level data based on actual tests on the fan sizes being furnished, and conducted in accordance with current AMCA standards. Such data is to define Sound Power Levels (PWL), re: 10-12 watts for each of the eight (8) frequency bands. Manufacturers furnishing estimate data will not be approved.

9. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate motor starters with Division 26 and controls contractor.
- B. Install in accordance with manufacturer's instructions.
- C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.
- D. Install unit on vibration isolators.
- E. Install 3" flexible duct connection at inlets and outlets of units.
- F. Control installers shall install all wiring associated with control signals into the fan starters.
- G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- H. Exhaust fans servicing risers with subducts shall operate continuously and shall be connected to backup generator power supply or other uninterruptible backup power as required by the Building Code and NFPA. Coordinate with Division 26 work. Center fans between four adjacent sprinklers.
 1. Vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of three feet.
 2. All HVLS fans to be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four-hours travel from the job site.

END OF SECTION

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SECTION 23 35 00
SPECIAL EXHAUST SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. Provide engineered variable volume exhaust system for each group of exhaust equipment. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
 - 1. Dust collection system.
- B. Section 23 05 00: Basic HVAC Materials and Methods
- C. Section 23 05 93: Testing, Adjusting and Balancing
- D. Section 23 09 00: Building Automation System (BAS) Controls
- E. Section 23 09 02: Variable Frequency Drives
- F. Section 23 31 13: Air Distribution
- G. Division 26: Electrical

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide exhaust fans and controls that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA):
 - a. 99-10 Standards Handbook
 - b. 99-0410 Classification for Spark Resistant Construction
 - 2. American Conference of Occupational Safety and Health (ACGIH) - Industrial Ventilation: A Manual of Recommended Practice.
 - 3. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of the exhaust systems, which comply with NEMA Standards.

4. National Fire Protection Association (NFPA): Provide internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. NFPA 70: National Electrical Code
 - b. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 - d. NFPA 91: Standard for Exhaust System for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.
 - e. NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
 - f. NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.
 - g. NFPA 664: Standard for Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities.
 - h. NFPA 1500: Standard on Fire Department Occupational Safety and Health Program.
5. National Institute for Occupational Safety and Health (NIOSH) - Current Intelligence Bulletin 50: Carcinogenic effects of exposure to diesel exhaust.
6. Occupational Safety and Health Administration (OSHA) – Part 1990 Identification, Classification, and Regulation of Carcinogens.
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.
 - a. UL 705 – Power Ventilators.
9. Canadian Standards Association (CSA)
 - a. CSA – CAN3-B255-M81 – Mechanical Flue-Gas Exhausters.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for exhaust fans showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations. Submit control devices and exhaust ductwork.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, required clearances, field connection details and methods of support. Draw to a scale of 1/4" per one foot.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.
- D. System Sizing Criteria:
 1. Exhaust fan location

- a. Outdoor wall or roof mount

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, lint filters are in place, bearings lubricated, and fan has been test run under observation.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.07 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Provide with two-year (24 months) warranty on entire fan assembly.
- D. Provide with ten-year warranty against corrosion perforation of exhaust fan cabinet and components.

PART 2 PRODUCTS

2.01 GENERAL SYSTEM REQUIREMENTS

- A. Provide a coordinated exhaust system including exhaust fan, nozzles, ductwork variable frequency drive, controller and duct pressure sensor, and ductwork for each interconnected exhaust system.

2.02 DUST COLLECTORS

- A. Cyclone dust collector system shall be capable of providing cyclonic cleaning of incoming product conveying air stream. Collector fan shall centrifugally move the heavy dirt and dust to the sidewalls of the collections assembly and thereby force the dust and dirt to the base of the unit for collection. System to be mounted outside the building and clean air to be exhausted directly to atmosphere. Dirt and dust shall be funneled into a 55-gallon drum (supplied by others) via a drum cover with transition. Collection system shall be factory-assembled and meet the airflow requirements as scheduled on the drawings. The collector shall be bolted and welded construction with a removable bottom cone section.
- B. Provide the following features, including options identified on the drawings:
 - 1. Stack silencer with outlet pointed away from noise sensitive direction.
 - 2. Steel or aluminum fan wheel.
 - 3. TEFC explosion proof motor.
 - 4. Final after filter assembly with MERV-15 filtration.
 - 5. Base and leg assembly.

6. Bottom outlet base support for 55-gallon drums.
 7. Multi-coat paint finish with 2,000-hour salt spray performance and color to match building. Coordinate color selection with Owner's Representative.
 8. Minimum 48" clearance beneath hopper funnel and top of 55-gallon drum.
 9. NEMA 4 control with timer and BAS interface for remote start/stop control.
 10. Magnehelic differential pressure gauge across filter media.
 11. 10-year warranty.
- C. Manufacturers: Donaldson Torit #Cyclone Series, United Air Specialists #C Series, Car-Mon or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Examine site to verify if site is ready to receive work. Provide layout drawings of exhaust fans, exhaust ductwork, controllers and transducers to the electrical installer.
- C. Install exhaust fan per manufacturer's installation instructions.
- D. Install 3" flexible duct connection at inlet to exhaust fan. Provide additional 3" flexible duct connection at outlet of inline fans.
- E. Provide accessories and fittings for complete and fully operational systems.
- F. Coordinate motor starters with Division 26 and controls contractor.
- G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four-hours travel from the job site.end of section

END OF SECTION

SECTION 23 41 00

AIR FILTRATION

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. This Section includes factory fabricated air filter devices and media utilized to remove particulate matter and gaseous contaminants in HVAC applications.
- B. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Air filters.
 - 2. Filter racks.
 - 3. Carbon filters.
 - 4. Odoroxidant media.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00: Basic HVAC Materials and Methods
- B. Section 23 31 13: Air Distribution

1.04 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
- B. IEST: Institute of Environmental Sciences and Technology
- C. UL: Underwriters Laboratories.
- D. Atmospheric Dust Spot Efficiency – per ASHRAE Standard 52.1 – Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. Information deleted as this Standard was closed by ASHRAE in 2008.
- E. DOP: Dioctyl Phthalate, a carcinogen that was part of the original military-defined process of testing HEPA filters, no longer used to evaluate filters. Where noted, HEPA/ULPA filters should be evaluated using polystyrene latex spheres (PSL).
- F. HEPA: High-Efficiency Particulate Air filter, a filter with a factory confirmed efficiency of no less than 99.97% when evaluated on particles 0.3 microns in size.

- G. ULPA: Ultra Low Penetration Air Filter, a filter with a factory confirmed efficiency of no less than 99.9995% when evaluated on particles 0.12 microns in size.
- H. HEGA: High Efficiency Gas Adsorber, box-style filter with a removal rate on specified contaminants exceeding 95%.
- I. MERV: Minimum Efficiency Reporting Value per ASHRAE Standard 52.2 - Method of Testing General Ventilation Air Cleaning Devices for Removal by Particle Size
- J. MERV-A: A value from Appendix J in ASHRAE Standard 52.2 that is reflective of an air filters ability to maintain efficiency over time. The MERV-A should be equivalent to the respective MERV of the specified filter.

Std. 52.2 MERV	Approx. Standard 52.1 Results		Application Guidelines		
	Dust Spot Efficiency	Arrestance	Typical Air Filter/Cleaner Type	Typical Controlled Contaminant	Typical Applications and Limitations
20	n/a	n/a	HEPA/ULPA Filters: >99.999% efficiency on 0.10-0.20µm articles, IEST Type F	<030µm Particle Size Virus (unattached) Carbon Dust Sea Salt All combustion smoke Random progeny 99.99% efficient in capturing Viruses (unattached) per NASA TM-2016- 218224	Cleanrooms Radioactive materials Pharmaceutical mfg. Carcinogenic materials Orthopedic surgery
19	n/a	n/a	>99.999% efficiency on 0.30µm particles, IEST Type D		
18	n/a	n/a	>99.99% efficiency on 0.30µm particles, IEST Type C		
17	n/a	n/a	>99.97% efficiency on 0.30µm particles, IEST Type A		
16	n/a	n/a	Bag Filters Non- supported (flexible) microfine fiberglass or synthetic media. 300 to 900 mm (12 to 36 inch) deep, 6 to 12 pockets. Box Filters Rigid Style cartridge filters 150 to 300 mm (6 to 12 inch) deep may use lofted (air laid) or paper (wet laid) media.	0.30-1.0µm Particle Size All bacteria Most tobacco smoke Droplet nuclei (sneeze) Cooking oil Most smoke Insecticide dust Copier toner Most Face powder Most paint pigments	Hospital inpatient care General surgery Superior commercial buildings
15	>95%	n/a			
14	90-95%	>98%			
13	80-90%	>98%			

12	70-75%	>95%	Bag Filters Non-supported (flexible) microfine fiberglass or synthetic media. 300 to 900 mm (12 to 36 inch) deep, 6 to 12 pockets. Box Filters Rigid Style cartridge filters 150 to 300 mm (6 to 12 inch) deep may use lofted (air laid) or paper (wet laid) media.	1.0-3.0µm Particle Size Legionella Humidifier dust Lead dust Milled flour Coal dust Auto emissions Nebulizer drops Welding fumes	Better commercial buildings Hospital laboratories
11	60-65%	>95%			
10	50-55%	>95%			
9	40-45%	>90%			
8	30-35%	>90%	Pleated Filters Disposable , extended surface, 25 to 100 mm (1 to 4 inch) thick with cotton-polyester blend media, cardboard frame. Cartridge Filters Graded density viscous coated cube or pocket filters, synthetic media Throwaway Disposable synthetic media panel filter.	3.0-10.0µm Particle Size Mold Spores Hair Spray Fabric protector Dusting aids Cement dust Pudding mix Powdered milk	Commercial buildings Better residential Industrial workplaces Paint booth inlet air
7	25-30%	>90%			
6	<20%	85-90%			
5	<20%	80-85%			
4	<20%	70-80%	Throwaway Disposable Fiberglass or synthetic panel fibers. Washable Aluminum mesh, latex coated animal hair, or foam rubber panel filter. Electrostatic Self charging (passive) woven polycarbonate panel filter.	>10.0µm Particle Size Pollen Spanish Moss Dust mites Sanding dust Spray paint dust Textile fibers Carpet fibers	Minimum filtration Residential Window air conditioners
3	<20%	70-75%			
2	<20%	65-70%			
1	<20%	<65%			

1.05 QUALITY ASSURANCE

- A. Codes and Standards: Provide filters conforming to the requirements of the latest addition of the following:
1. ANSI/AHRI-850: Performance Rating of Commercial and Industrial Air Filter Equipment.
 2. UL-900: Standard for Safety Air Filter Units.
 3. UL-586: Standard for High-Efficiency, Particulate, Air Filter Units.

4. ASHRAE 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. NFPA-70: National Electrical Code.
6. NFPA-90A: Standard for the Installation of Air-Conditioning and Ventilating Systems.
7. NFPA-90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
8. IEST-RP-CC001: HEPA and ULPA Filters.

B. Design Criteria

1. Air flow not to exceed rated capacity
2. Initial and final resistance not to exceed scheduled values.
3. Air filters shall be accessible for cleaning or replacement.

C. Manufacturer shall provide evidence of facility certification to ISO-9001:2008.

1.06 SUBMITTALS

- A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final (with dirty filter allowance) pressure drop at rated airflow; efficiency and test method; UL classification; furnished specialties; and accessories for each model indicated. Manufacturers literature and sales drawings acceptable.
- B. Shop Drawings: Include plans, evaluations, sections, and details to illustrate component assemblies and attachments.
- C. Show filter holding mechanism assembly, dimensions, materials and methods of installation and sealing in drawings.
- D. Include setting drawings, templates and requirements for installing anchor bolts and anchorages.
- E. Operation and Maintenance Data: For each type of filter and filter holding mechanism to include in emergency, operation and maintenance manuals.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect all products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged materials from project site.
- C. Furnish extra filters that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel. This requirement excludes disposable filter media.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following (for HVAC Air Filters, Terminal HEPA Filter Modules, Adsorbers, Built-up Bank Holding Frames, Side-Access Housings and Bag-in/Bag-out Containment Housings):
1. Camfil (Farr)
 2. American Air Filter International (Flanders, PrecisionAire)
 3. Filtration Group <https://store.filtrationgroup.com/hvac/hvac-pleated-air-filters>
 4. Clarcor Air Filtration Products (AirGuard, ATI, Purolator)
 5. Eco-Air
- B. Air Filter Gages and Pressure Switches
1. Dwyer Instruments
- C. Non-ionizing, polarized media electronic air cleaners
1. Dynamic Air Quality Solutions

2.02 CONSTRUCTION FILTERS – MERV-7

- A. Air handling equipment shall not be operated without construction pre-filters in place and shall be medium efficiency, extended area, disposable type of the quantity and size indicated on the drawings.
- B. The filter media shall have a minimum efficiency reporting value of MERV-7 when evaluated under the guidelines of ASHRAE Standard 52.2.
- C. The filter media area and initial resistance shall be:
- | | | |
|-------------------------|---------------------------|--------------------|
| 1. For a 2" deep filter | 10 pleats per linear foot | Maximum 0.28" w.g. |
| 2. For a 4" deep filter | 9 pleats per linear foot | Maximum 0.20" w.g. |
- D. Manufacturer: Camfil #Aeropleat III or equal.

2.03 PREFILTERS AND SINGLE-STAGE PRIMARY FILTERS – EFFICIENCY MERV 8

- A. Air handling equipment shall not to be operated without filters installed (ex: see construction filter section). Minimum efficiency during normal operation shall be no less than MERV 8.
- B. The filter shall have a minimum efficiency reporting value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2.
- C. Each filter shall consist of a cotton and synthetic blend media, a welded wire media support grid and a high wet-strength beverage board enclosing frame.
- D. The filter media area and initial resistance shall be:
- | | | |
|-------------------------|---------------------------|--------------------|
| 1. For a 2" deep filter | 15 pleats per linear foot | Maximum 0.31" w.g. |
| 2. For a 4" deep filter | 11 pleats per linear foot | Maximum 0.27" w.g. |

- E. Manufacturer: Camfil #Farr 30/30 or equal.

2.04 SINGLE-STAGE 1" AND 2" PRIMARY FILTERS – EFFICIENCY MERV 13

- A. The filter shall have a minimum efficiency reporting value of MERV 13 when evaluated under the guidelines of ASHRAE Standard 52.2. Final resistance of 1.0" w.g.
- B. Each filter shall consist of a cotton and synthetic blend media, a welded wire media support grid and a high wet-strength beverage board enclosing frame.
- C. The filter media area and initial resistance shall be:
1. 1" filter depth 15 pleats per linear foot Initial Resistance 0.47" at 375 fpm.
 2. 2" filter depth 15 pleats per linear foot Initial Resistance 0.25" at 375 fpm.
 3. 4" filter depth 12 pleats per linear foot Initial Resistance 0.29" at 500 fpm.
- D. Manufacturer: Filtration Group #Aerostar Green Pleat, or equal.

2.05 SECONDARY FILTERS – MINI-PLEAT 4" DEEP TYPE EFFICIENCY MERV 11, 13, OR 14 AS NOTED ON DRAWINGS

- A. Air filters shall be 4" deep high efficiency ASHRAE box style filters consisting of mini-pleated wet laid fine fiber media, thermoplastic resin separators, frame to media adhesive and high wet strength beverage board enclosing frame. Sizes shall be as noted on drawings or other supporting materials.
- B. Filter media shall be of one continuous sheet of micro fine wet-laid glass mat filter media formed into uniformly spaced pleats and formed into a mini-pleat pack configuration. Thermoplastic pleat separators shall provide uniform media separation to promote uniform airflow throughout the media. The enclosing frame shall be of high wet strength beverage board which shall be bonded to the entire periphery of the media pack to prevent air bypass. The frame shall include integral diagonal support members to ensure maintained media spacing and pleat stability. The diagonal support members shall be bridge-engineered to prevent filter racking and ensure filter configuration integrity. Filter shall be bi-directional with regard to airflow.
- C. The filter shall have a Minimum Efficiency Reporting Value of MERV-11, MERV-13 or MERV-14 as stated on the drawings.
- D. The filter shall be capable of withstanding 5" w.g. without failure of the media pack.
- E. Performance of the filter shall comply with the following minimum performance data based on a 24" by 24" by 4" filter tested at 2000 CFM.
- F. Minimum Filter Requirements:

Efficiency	Initial Resistance (w.g.)	Media Area
MERV 11	0.33"	113 sq. ft. based upon 24" by 24" by 4 size
MERV 13	0.44"	113 sq. ft. based upon 24" by 24" by 4 size
MERV 14	0.60"	113 sq. ft. based upon 24" by 24" by 4 size

- G. Manufacturer: Camfil #Opti-Pac or equal.

2.06 SECONDARY FILTERS – DEEP PLEAT 12” DEEP BOX-STYLE - EFFICIENCY MERV 11, 13, OR 14 AS NOTED ON DRAWINGS

- A. Air filters shall be high-efficiency ASHRAE high lofted supported media disposable type assembled in a compact and secure enclosing frame. Sizes shall be as noted on drawings.
- B. The filter media shall be of micro fine glass laminated to a reinforcing backing to form a uniform lofted media blanket. The media blanket shall be formed into uniform tapered radial pleats and bonded to a stiffened backing that is bonded to the downstream side of the media to preclude media oscillation. The media shall be mechanically and chemically bonded within the frame to prevent air bypass. The enclosing frame shall be constructed of corrosion resistant galvanized steel. Media support contour stabilizers shall be mechanically fastened to diagonal support members to create a rigid and durable filter enclosure. There shall be a minimum of four contour stabilizers on the air entering side and four on the air exiting side.
- C. The filter shall have a Minimum Efficiency Reporting Value of MERV-9, MERV-11, MERV-13, or MERV-14 as stated on the drawings.
- D. The filter shall be capable of withstanding 10” w.g. without failure of the media pack.
- E. Performance of the filter shall comply with the following minimum filter performance data based on a 24” by 24” by 12” filter tested at 2000 CFM:

Efficiency	Initial Resistance (w.g.)	Media Area
MERV 9 & 9-A	0.36”	58 sq. ft. based upon 24” by 24” by 12 size
MERV 11 & 11-A	0.31”	53 sq. ft. based upon 24” by 24” by 12 size
MERV 13 & 13-A	0.41”	53 sq. ft. based upon 24” by 24” by 12 size
MERV 14 & 14-A	0.53”	53 sq. ft. based upon 24” by 24” by 12 size

- F. Manufacturer: Camfil #Riga-Flo or equal.

2.07 SECONDARY FILTERS – DEEP PLEATED 12” V-BANK STYLE PLEAT-IN-PLEAT BOX-STYLE - EFFICIENCY MERV 11, 13, OR 14 AS NOTED ON DRAWINGS

- A. Air filters shall be high-efficiency ASHRAE pleat-in-pleat V-bank disposable type assembled in a compact and secure enclosing frame. Sizes shall be as noted on drawings or other supporting materials.

- B. Filter media shall be of micro fine glass formed into uniformly spaced pleats separated by glass filament separators and formed into a mini-pleat pack design. Each mini-pleat pack shall be assembled into a V-bank configuration with an appropriate number of packs to obtain required pressure drop. The media packs shall be bonded to the inside periphery of the enclosing frame with a fire-retardant phosphorus-free sealant. The enclosing frame shall include modular injection-molded plastic channels bonded to the media pack to prevent air bypass. Injection-molded modular plastic supports shall be placed on the air entering and air exiting sides. The filter shall have a nominal 1" header that is an integral component of the enclosing frame. Injection-molded rigid plastic end caps shall be bonded to the top and bottom of the enclosing structure to ensure a rigid and durable filter. A gasket shall be included on header-to-header sealing surfaces to eliminate air bypass between headered filters. Filter shall be bi-directional with regard to airflow.
- C. The filter shall have a Minimum Efficiency Reporting Value of MERV-11, MERV-13, MERV-14, or MERV-16 as stated on the drawings.
- D. Performance of the filter shall comply with the following minimum filter performance data based upon a 24" by 24" by 12" deep filter tested at 2000 cfm:

Efficiency	Initial Resistance (w.g.)	Media Area
MERV 11 & 11-A	0.22"	200 sq. ft. based upon 24" by 24" by 12 size
MERV 13 & 13-A	0.27"	200 sq. ft. based upon 24" by 24" by 12 size
MERV 14 & 14-A	0.29"	200 sq. ft. based upon 24" by 24" by 12 size
MERV 16 & 16-A	0.64"	200 sq. ft. based upon 24" by 24" by 12 size

- E. The filter shall be capable of withstanding 10" w.g. without failure of the media pack.
- F. Manufacturer: Camfil #Durafil or equal.
- 2.08 SECONDARY (OR SINGLE-STAGE) FILTERS – MULTI-POCKET HIGH EFFICIENCY MERV 11, 13, OR 14 AS NOTED ON DRAWINGS

- A. Air filters shall be high efficiency ASHRAE extended surface pocket style filters consisting of high loft air laid micro fine glass media, a reinforced ABS plastic header, ABS plastic pocket retainers, and bonding agents to prevent air bypass and ensure leak free performance.
- B. Filter media shall consist of high-density air laid lofted micro fine glass media that is chemically bonded to a synthetic micro mesh media support backing forming a lofted filter blanket.
- C. Individual pockets shall contain a minimum of 40 stitching support points per square foot of media area. All stitching centers shall be sealed through the use of a foam based sealant that shall remain pliable throughout the life of the filter. The sides and ends of each pocket shall be sewn with a chain-link over lock stitch.
- D. Pockets shall be formed into tapered pleats, supported by controlled media space stitching, to promote uniform airflow across the surface of the media. At any point, the sizes of the upstream and downstream passages shall be proportional to the volume of filtered air. The pockets shall also have a conical configuration to minimize contact with HVAC system components.

- E. Support members shall include an ABS plastic header and ABS plastic pocket retainers. The header shall be joined to the media to prevent air bypass. Individual pocket retainers shall be attached to the header frame with anchor ports allowing for visual confirmation. Bypass between pockets shall be eliminated through a snap-to-seal pocket retainer that shall be an integral part of the two-piece header design. The frame shall form a rigid and durable support assembly.
- F. The air exiting side of the air tunnels include a pocket flange to ensure pocket integrity throughout the life of the filter. A downstream pocket-to-pocket partition shall provide additional pocket separation to ensure full flow through the entire media area.
- G. A filter-to-filter sealing gasket shall be installed on one of the vertical members of the filter header.
- H. The filter shall have a Minimum Efficiency Reporting Value of MERV-11, MERV-13, MERV-14, or MERV-15 as stated on the drawings.
- I. Performance of the filter shall comply with the following minimum filter performance data based upon a 24" by 24" by 22" deep 8-pocket filter tested at 2000 cfm:

Efficiency	Initial Resistance (w.g.)	Media Area
MERV 9 & 9-A	0.20"	58 sq. ft. based upon 24" by 24" by 22" size
MERV 11 & 11-A	0.28"	58 sq. ft. based upon 24" by 24" by 22" size
MERV 13 & 13-A	0.45"	58 sq. ft. based upon 24" by 24" by 22" size
MERV 14 & 14-A	0.68"	58 sq. ft. based upon 24" by 24" by 22" size

- J. The manufacturer shall warranty that the filter shall be capable of withstanding 10.0" w.g. without failure of the filter.
- K. Manufacturer: Camfil #Hi-Flo ES or equal.
- 2.09 HEPA FILTER – STANDARD CAPACITY – ALUMINUM SEPARATORS – (99.97%, 99.99%) - 12" DEEP AS NOTED ON THE DRAWINGS
- A. Air filters shall be HEPA grade standard capacity air filters with waterproof micro glass fiber media, corrugated aluminum separators, urethane sealant, a galvanized 16-gauge steel enclosing frame and sealing gasket. Sizes shall be as noted on drawings or other supporting materials.
- B. Filter media shall be one continuous pleating of micro fine glass fiber media. Pleats shall be uniformly separated by corrugated aluminum separators incorporating a hemmed edge to prevent damage to the media. The media pack shall be potted into the enclosing frame with a fire-retardant urethane sealant. The enclosing frame shall be of galvanized 16-gauge steel, shall be bonded to the media pack to form a rugged and durable enclosure. The filter shall be assembled without the use of fasteners to ensure no frame penetrations. Overall dimensional tolerance shall be correct within $-1/8"$, $+0"$, and square within $1/8"$. A poured-in-place seamless sealing gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.

- C. The filter shall have a tested efficiency of 99.97%, 99.99%, or 99.999% as stated on the drawings when evaluated according to IEST Recommended Practice. Initial resistance to airflow shall not exceed 1.0" w.g. at rated capacity.
 - D. The filter shall be capable of withstanding 10" w.g. without failure of the media pack.
 - E. Manufacturer: Camfil #Absolute XS or equal.
- 2.10 HEPA FILTER – HIGH CAPACITY – ALUMINUM SEPARATORS – (99.97%, 99.99%) -12" DEEP AS NOTED ON THE DRAWINGS
- A. HEPA filters shall be HEPA grade high-capacity air filters with waterproof micro glass fiber media, tapered corrugated aluminum separators, urethane sealant, a galvanized 16-gauge steel enclosing frame, and (neoprene sealing gasket, seamless gasket). Sizes shall be as noted on drawings.
 - B. Filter media shall be one continuous pleating of micro glass fiber media. Pleats shall be uniformly separated by tapered corrugated aluminum separators incorporating a hemmed edge to prevent damage to the media. The media pack shall be potted into the enclosing frame through the use of a urethane sealant. The enclosing frame of galvanized 16-gauge steel, shall be bonded to the media pack and form a rugged and durable enclosure. The filter shall be assembled without the use of fasteners to assure no frame penetrations. Overall dimensional tolerance shall be correct within -1/8", +0", and square within 1/8". A poured-in-place seamless sealing gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.
 - C. The filter shall have a tested efficiency of 99.97%, 99.99%, 99.999% as stated on the drawings when evaluated under the guidance of IEST Recommended Practice RP-CC001.
 - D. Initial resistance to airflow shall not exceed 1.35" w.g. at rated capacity. The filter shall be capable of withstanding 10" w.g. without failure of the media pack.
 - E. All filters shall be bagged and packaged in heavy-duty cardboard boxes. Each box shall contain a liner to minimize shock and vibration of the HEPA filter.
 - F. Manufacturer: Camfil #Absolute XH or equal.
- 2.11 HEPA FILTERS – ULTRA HIGH CAPACITY – PLEAT-IN-PLEAT V-STYLE (95%, 99.97%, 99.99%) AS NOTED ON THE DRAWINGS
- A. Air filters shall be absolute grade HEPA filters consisting of pleated media packs assembled in a V-bank configuration, polyurethane sealant, anodized aluminum enclosure and seamless sealing gasket. Sizes shall be as noted on enclosed drawings.
 - B. Filter media shall be micro fiber glass formed into minipleat pleat-in-pleat V-bank design. The media packs shall be potted into the enclosing frame with fire retardant polyurethane sealant. An enclosing frame of anodized extruded aluminum shall form a rugged and durable enclosure. A seamless sealing gasket shall be included on the downstream side of the filter to form a positive seal upon installation.
 - C. Filter efficiency at 0.3 micron shall be 95%, 99.99%, 99.999% as stated on the drawings when evaluated according to the IEST Recommended Practice for applicable type. Initial resistance shall not exceed 1.0" w.g. at rated capacity or 0.50" w.g. for 95% filters.

- D. All filters shall be bagged and packaged in heavy-duty cardboard boxes. Each box shall contain a liner to minimize shock and vibration of the HEPA filter.
- E. Manufacturer: Camfil #Filtra 2000 or equal.

2.12 DUCTED LAMINAR FLOW TERMINAL HEPA FILTER HOUSINGS AND FILTERS -99.99% (ROOM SIDE REPLACEABLE)

- A. Filter housing shall include anodized aluminum module, offset filter knife-edge for gel seal filter mating, stainless steel mounting hardware and adjustable air diffusion disc. Sizes shall be as noted on drawings. Primary housing components shall be constructed of anodized aluminum framing material, aluminum back plate and aluminum diffusion disk. Unit shall be designed for installation into T-Bar ceiling grid or a gypsum/plaster ceiling. The housing shall include a chamfered detail along the room side opening to receive a mating flange along the downstream side of the filter. The mating surface shall form a continuous flush fit free of gaps. The housing shall include an offset knife-edge to interface with a gel seal filter. Stainless steel mounting hardware shall facilitate convenient servicing of the module from the room side of the housing. The housing shall include an integral diffusion disc that allows filter-to-filter balancing from room side of module without removal of the filter. Housing shall be supplied with a 10" or 12" collar for duct connection to air system. The collar shall include an integral continuous raised ridge to assist in securing flexible duct.
- B. Air filters shall be high efficiency individually tested and certified panel filters consisting of aluminum enclosing frame, low-outgassing sealant, continuous filament pleat separators and micro glass media filter pack. Sizes shall be as noted on drawings or other supporting materials. Filter shall be manufactured in a Class 10,000 (M5.5, ISO Class 7) cleanroom and tested in a Class 100 (M3.5, ISO Class 5) clean space. Filter media shall be one continuous pleating of micro glass fiber media formed into a uniform pack depth. Pleat spacing shall be by continuous glass filament separators to prevent media-to-media contact and promote uniform airflow through the media pack. The media pack shall be completely encapsulated in a polyurethane sealant creating a rigid self-supporting pack. The sealant shall be low out gassing, fire-retardant and self-extinguishing. The enclosing frame, of anodized aluminum profiles, shall be joined together with secure internal corner clips to form a rugged and durable enclosure. Overall dimensional tolerance shall be correct within +0, -1/8", and square within 1/4". Gaskets, unless otherwise noted, shall be low outgassing cleanroom grade cellular urethane foam. Corners shall be dovetailed to form an interlocking joint and positive seal.
- C. Manufacturer: Filter module and filter shall be Camfil Slimline RSR and Camfil Megalam panel or equals.

2.13 TERMINAL HEPA MODULES (DISPOSABLE) – 99.99%

- A. Unit shall be ducted high efficiency ceiling module consisting of anodized aluminum frame, a galvanized back plate, 41-mm filter pack, polyurethane encapsulating sealant and dual access ports. Maximum module depth shall not exceed 4.73". Sizes shall be as noted on drawings. Filter housing shall be constructed of an anodized aluminum frame mated with a galvanized steel back plate. It shall be designed for installation into a T-Bar ceiling grid system. The media pack shall have a maximum depth of 1.61" (41 mm) and shall have an efficiency of 95 @ 0.3 micron, 99.99% @ 0.3 micron, 99.9995% @ MPPS. Pleat spacing shall be by continuous glass filament separators to prevent media-to-media contact and promote uniform airflow through the media pack. The media pack shall be completely encapsulated in a polyurethane sealant creating a rigid self-supporting pack. The sealant shall be low out gassing, fire-retardant and self-extinguishing. The module shall include an adjustable airflow diffusion disc that is adjustable from the room side through an access port. A second port, accessible from the room side, shall be provided to allow aerosol test challenge introduction or pressure drop

measurement. Housing shall be supplied with a 10" or 12" collar that includes an integral continuous raised ridge for duct side connection to air system.

B. Manufacturers: Camfil #Megalum Terminal Diffuser or equal.

2.14 FAN POWERED HEPA FILTER MODULES – 99.99% (ROOM SIDE REPLACEABLE) (NOTE TO EDITOR: RARELY USED.)

A. Self-contained fan powered HEPA filter module. Refer to schedule on drawings.

B. Module shall provide vertical laminar air flow. Unit to meet or exceed IEST-RP2 Specifications for Laminar Air flow devices, 90 FPM+/- 10 FPM.

C. Fan Filter Modules shall be UL listed.

D. Filter Media: Separatorless, high strength, water-proof, micro-fiberglass High Efficiency Particulate Air (HEPA) filter with a minimum efficiency of 99.99% at 0.3 micron, aerosol challenged.

E. Motor/Blower Assembly: Direct drive continuous duty motor with inherent overload protection. Assembly is designed to provide rate airflow through an increase from 0.425" to 0.85" w.g.

F. Construction

1. Aluminum filter plenum with integral blower housing.

2. Threaded nuts in each corner to seismic hanger loops.

3. HEPA filter, factory sealed in an extruded aluminum frame for leak-free operation, furnished with a neoprene gasket.

4. The filter face guard shall be removable, perforated anodized aluminum screen.

G. Sound level: Sound level shall not exceed 53 dBA at three feet at normal operation levels.

H. Vibration shall not exceed 0.1 micro inch. Average to be 0.05 mil peak to peak.

I. Options to be included:

1. Solid-state speed control.

2. 12-inch diameter duct collar for 24" x 48" and 10-inch diameter collar for 24" x 24".

3. Room side replaceable filter construction, which allows filter removal and installation without disturbing the unit or adjacent ceiling components.

4. Adaptor to allow fan powered HEPA filter installation in a gypsum board ceiling.

2.15 ADSORBER – ACTIVATED CARBON ADSORBERS – MOLECULAR CONTAMINANT REMOVAL – HEGA

- A. Air filters shall be high efficiency gas adsorbers, with (adsorbent selection), (number of beds) adsorbent beds, a (bed depth) bed depth enclosed in a high-impact polystyrene enclosing frame. Sizes shall be as noted on drawings. Adsorbent shall be (activated virgin coconut shell carbon, nuclear grade carbon, ASZM-TEDA carbon). There shall be (number of beds) beds of adsorbent arranged in a V-bank configuration to reduce system resistance to airflow. Adsorbent bed depth shall be (1", 2"). Adsorber screens shall be perforated and supported by external spacers to prevent bed distortion during filling and shake process. The enclosing frame shall be of high-impact polystyrene plastic and shall be designed for disposal through incineration. The frame shall form a rigid and durable enclosure. A 1/4" thick neoprene sealing gasket shall be included on the upstream side of the HEGA enclosing frame to form a positive seal upon installation.
- B. The HEGA shall have a minimum mechanical efficiency of 99.9%, and be tested and packaged in accordance with IEST-RP-CC-008-84. The HEGA filter shall be capable of operation to 120°F. The filter bed shall have a residence time of (insert value) seconds at (rated airflow) cfm.
- C. Manufacturer: Camfil or equal.

2.16 UNIVERSAL ASHRAE GRADE HOLDING FRAMES

- A. Filter holding frame shall be constructed of 16-gauge galvanized steel. The frame shall be assembled from two corner sections and welded to assure a rigid and durable frame assembly for built-up bank HVAC level application. Centering dimples shall be an integral part of the frame to assist in aligning final filter and pre-filter if applied.
- B. Frame-to-frame installation holes shall be an integral part of the frame, two holes on each vertical and three holes on top and bottom. The top of the frame shall be identified with etching.
- C. The frame shall include eight integral corrosion resistant compression tabs, four on each horizontal member, to facilitate filter installation without the use of tools or other fasteners.
- D. A 3/4" filter sealing flange shall be an integral component of the holding frame. All corners shall be flush mitered.
- E. A replaceable filter-to-frame sealing gasket shall be installed on the flange to prevent air bypass and ensure that the filter seats securely against the sealing flange.
- F. Holding Frames shall be assembled to form built-up filter banks with the use of nuts and bolts and vertical support members as detailed on manufacturer provided drawings. (Refer to details of assembly and support drawings.)
- G. Dow 732 Sealant shall be applied to the periphery of all holding frames prior to clamping, assembly and bolting.
- H. Manufacturer: Camfil FastFrame or equal.

2.17 TWO STAGE SIDE ACCESS FILTER HOUSING FOR ASHRAE PARTICULATE FILTERS (SIDE LOADING)

- A. Filter housing shall be multi-stage air filter housing consisting of 16-gauge galvanized steel enclosure, multi-filter adaptable extruded aluminum filter mounting track, dual-access doors, three static pressure taps, door and filter gaskets and seals. In-line housing depth shall not exceed 25".

- B. Sizes shall be as noted on drawings.
- C. The housing shall be constructed of 16-gauge galvanized steel, stainless steel, or aluminum with standing flanges to facilitate attachment to other HVAC system components. Corner posts of Z-channel construction shall ensure housing stability and rigidity. The housing shall be weatherproof and suitable for rooftop/outdoor installation without modification.
- D. The housing shall incorporate the capability of multiple stages of filtration without modification to the housing. A filter track, of extruded aluminum construction shall be an integral component of housing construction. The track shall accommodate a 2" or 4" deep pre-filter, a 2" or 4" deep intermediate particulate or carbon filter, and a 6" or 12" deep rigid or pocket final filter.
- E. Dual access swing-open doors shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal against all individual stages of filtration. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges.
- F. The housing shall include three pneumatic fittings to allow the installation of static pressure gauge(s) to evaluate pressure drop across the pre-filter, the secondary filter, the final filter, or any combination of the installed filters.
- G. Leakage at rated airflow, upstream to downstream of filter and slide mechanism shall not exceed 1% at 3.0" w.g. Leakage into or out of the housing shall be less than 1% at 3.0" w.g.
- H. Accuracy of pneumatic pressure fittings, when used to evaluate a single-stage, or multiple filter stages, shall be accurate within $\pm 3\%$ at 0.6" w.g.
- I. Housing integrity to listed performance values shall be available on request from the housing manufacturer.
- J. Manufacturer: Camfil #GlidePack MultiTrack 25 or equal.

2.18 SIDE ACCESS ADSORBER HOUSING WITH CARBON CANISTERS

- A. Air filters shall be (plastic disposable, stainless steel factory rechargeable) loose-fill sorbent canisters and matching (face-access holding frames, side access housings). Canister size shall be (5.7" diameter x 18" length, 5.7" diameter x 24" length). There shall be 16 canisters per 2000 cfm rated airflow at 500 fpm.
- B. Sorbent canisters shall be constructed of (disposable ABS + HDPE plastic, refillable 22-gauge stainless steel) and shall be capped with a (plastic, stainless steel) end plate. Each canister shall include a minimum of (30, 115) airflow perforations per square inch of cylinder surface area. Perforations shall be a minimum of (0.090", 0.060") diameter in size. Each canister shall include a mounting assembly with three integral bayonets for mounting to matching cylindrical mounting flange/frame. An integral gasket seal shall be factory-installed to ensure a bypass-free seal to the mounting flange/frame. Each canister shall contain at least 0.0485 cu. ft. of sorbent per 6" of canister length. Media bed depth shall be 1.0".

- C. Sorbent shall be Camfil (select one of the following): (CFS – 201 activated carbon), (CFS - 202, impregnated carbon for adsorption of corrosive and acidic gases), (CFS – 204, impregnated carbon for adsorption of ammonia and basic gases), (CFS - 101, activated alumina impregnated with Campure 4, 4% potassium permanganate), (CFS - 103, activated alumina impregnated with Campure 6XL, 6% potassium permanganate and proprietary impregnations), (CFS-102, -- activated alumina impregnated with Campure 8, 8% potassium permanganate), (CFS - 002, blended activated carbon and Campure 4),(CFS - 004, blended activated carbon and Campure 6XL). Manufacturer may recommend blends of the adsorbent medias listed above or other sorbent medias as dictated by the intended application.
- D. System pressure drop shall not exceed (0.63, 0.59)" w.g. at a velocity of 500 fpm when proper quantity of (18", 24") cylinders are mounted to matching canister holding frame(s). Canister to mounting hardware procedure shall form a mechanical connection with a seal limiting air bypass across canister mounting assembly. Initial single-pass removal efficiency shall be >95% for specified gases, per manufacturer's test methodology at gas concentrations no greater than 100 ppm. Manufacturer shall demonstrate uniformity of air flow via computational fluid. Manufacturer shall document adsorbent capacity of canisters to a minimum required removal efficiency for representative molecular contaminant(s)*.
- E. Canister installation shall provide sound attenuation of at least +5 dBA at 220 Hz, +10 dBA at 440 Hz, and +15 dBA at 1760 Hz. Manufacturer shall provide an independent report of canister sound attenuation performance from a recognized testing laboratory. Initial resistance to airflow with charged panels installed shall not exceed 0.35" w.g. at 500 fpm.

2.19 HEPA FILTER HOLDING FRAMES (FOR BUILT-UP BANKS) (GASKET SEAL OR FLUID SEAL)

- A. Gasket seal holding frames shall be constructed of 14-gauge galvanized steel or 304 SST. Frames shall be welded and include centering dimples, pre-drilled mounting holes, filter sealing flange and swing bolt assemblies. An appropriate number of swing bolts to match air filters shall also be included. Sizes shall be as noted on drawings. Annular based centering dimples shall be an integral component to assist in proper seating of filter gasket to filter sealing flange. Assembly holes shall be within dimples to recess assembly bolts. Filter securing swing bolt assemblies, of the same construction as the frame, shall be offset to facilitate multiple filter installations. The assembly shall include appropriate swing bolts to match filter depth and equi-bearing clamps to allow uniform filter gasket sealing. The sealing assembly shall be capable of sealing each element with 30 inch/lbs. of torque to 50% filter gasket compression.
 - 1. Manufacturer: Camfil MagnaFrame II or equal.
- B. Fluid seal holding frames shall be constructed of 14-gauge galvanized steel or 304 SST. Frames shall be welded and include centering dimples, pre-drilled mounting holes, knife-edge filter sealing flange and swing bolt assemblies. An appropriate number of swing bolts to match air filters shall also be included. Sizes shall be as noted on drawings. Filter frame shall be all-welded construction of 14-gauge galvanized steel or 304 SST. The frame shall include pre-drilled mounting holes to align frame-to-frame and ensure built-up bank support. Annular based centering dimples shall be an integral component to assist in proper seating of filter gel seal channel to frame sealing knife-edge. Assembly holes shall be within dimples to recess assembly fasteners. Additional filter receptacle guides on the top and bottom of the holding frame shall assist in filter alignment. Filter securing swing bolt assemblies, of the same construction as the frame, shall be offset to facilitate multiple filter installations. The assembly shall include appropriate swing bolts to match filter depth and equi-bearing clamps to allow uniform filter sealing. The sealing assembly shall create a scan capable filter to frame assembly seal.

1. Manufacturer: Camfil MagnaFrame III or equal.

2.20 CONTAINMENT – BAG-IN/BAG-OUT HOUSINGS

- A. Side-access bag-in/bag-out, gasket seal housing. The housing shall be adequately reinforced to withstand a negative or positive pressure of 15" water gage. Housing design and filter arrangement shall allow air to enter and exit housing without changing direction. The housing shall accommodate standard size filters that do not require any special attachments or devices to function properly in the housing. Sizes shall be noted on drawings.
- B. Housing shall be constructed of 14-gauge and 11-gauge T-304 stainless steel. All pressure retaining joints and seams shall be continuously welded with no porosities. Joints and seams requiring intermittent welds, such as reinforcement members, shall be intermittently welded. Housing shall be free of burrs and sharp edges. All weld joints and seams that are a portion of any gasket setting surface (duct connection flanges and filter sealing surfaces), shall be ground smooth and flush with adjacent base metals. All welded joints and seams shall be wire brushed to remove heat discoloration. The housing shall be reinforced to withstand a positive or negative pressure of 15" w.g. The upstream and downstream ductwork connections shall have 1 1/2" outward-turned flanges.
- C. The housing shall have a bagging ring around each filter access port that is sealed by a gasketed filter access door. The filter access door gasket shall be silicone and shall be replaceable, if necessary. The bagging ring shall have two (2) continuous formed raised ridges to secure the PVC change-out bag. The bagging ring shall be hemmed on the outer edge to prevent the change-out bag from tearing.
- D. Ancillary hardware including filter clamping mechanism, door handles, door studs and labels shall be 300 series stainless steel. The threaded pivot blocks in the filter clamping mechanisms shall be of brass construction. Filter access door knobs shall be cast aluminum and designed to prevent galling of threads.
- E. A filter clamping mechanism shall be operated by means of a standard wrench from outside the housing. The clamping mechanism shall include two pressure channel assemblies with eight springs per filter and exert a minimum filter sealing force of 1,400 pounds per full size filter, 1050 pounds per half size filter, and 700 pounds per quarter size filter. The force shall be applied as an even, uniform load along at least 80% of the top and bottom of each filter outer frame. The filter clamping mechanism adjustment penetration through the housing wall shall be sealed airtight.
- F. One (1) manufactured PVC change-out bag shall be furnished with each filter access port. Change-out bags shall be 8-mil. thick with a yellow translucent, non-sticking, matte finish. It shall include a 1/4" diameter elastic shock cord hemmed into the opening of the bag so when stretched around the housing bagging ring flange, a secure fit is created. The bag shall include three (3) integral glove ports to assist in filter change-out. One (1) nylon security strap shall be included per filter access port to prevent the bag from sliding off the bagging flange during the change-out process. Design of components shall be such that all change-out operations shall be within the bag so there is a barrier between the worker and the filter at all times.
- G. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX and AWS D9.1 Specification for Welding of Sheet Metal. All production welds shall be visually inspected by qualified personnel.

- H. The filter housing shall be factory tested for filter fit, flatness of filter sealing surface and operation of filter clamping mechanism. The filter sealing surface and the complete assembly pressure boundary shall be leak tested by the pressure decay method as defined in ASME N510 Testing of Nuclear Air Cleaning Systems. The filter sealing surface shall be tested at +10" water gage and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume. The overall system pressure boundary shall be leak tested at +15" water gage and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume.
- I. Filter bags shall be capable of continuous operating to temperature extremes of 0°F to 150°F.
- J. Multi-wide housing shall be equipped with a filter removal rod to pull the filters to the change-out position. The removal rod shall operate from the inside of the filter change out bag.
- K. Manufacturer: Camfil GB-series or equal.

2.21 NON-IONIZING, POLARIZED MEDIA ELECTRONIC AIR CLEANERS

- A. Operation: The Air Cleaner shall have an active electrostatic field that polarizes a dielectric media. It shall not ionize airborne particles or produce ozone.
- B. Laboratory Testing Performance: Using the ASHRAE 52.2 protocol with carbon black in the test dust, the Air Cleaner shall test at MERV 13. Using the ASHRAE 52.2-NC protocol (with no carbon in the loading dust), the Air Cleaner shall test at MERV 15. As installed, it shall have a clean static pressure drop of less than 0.3" w.g. at 500 feet per minute and shall increase in resistance no more than 0.25" w.g. with a dust loading of 2,855 grams. It shall hold a total of 4,582 grams of dust at its final resistance of 1.4" w.g. per 24x24 module. Any substitute Air Cleaner must meet these MERV ratings, static pressures and loading characteristics. The Air Cleaner manufacturer must provide testing from an approved ASHRAE test lab to verify MERV rating, operational and loading performance.
- C. Field Performance: The Air Cleaner manufacturer shall produce at least two documented installation references, including client contact information with the following criteria:
 - 1. Air Cleaners shall have operated continuously for a minimum of 2.5 years with no pre-filtration and without media change and achieved an increase of less than .2 inches of static pressure at a face velocity of ~500fpm, in an urban environment. Air cleaner installations must be greater than 10,000 cfm and serving office and/or hospital space.
 - 2. In an urban environment, Air Cleaners must have demonstrated the ability to achieve indoor ultra-fine particle and black carbon levels that are up to 94% lower than the concentrations in the air outside the building. Outdoor air levels brought into in the building must be based on the ASHRAE Standard 62 Ventilation Rate Procedure.
 - 3. Air Cleaners shall have a documented ability to reduce TVOC levels by 50-60% in a single pass. Air Cleaners must have already been in service for over 90 days. Tests must be administered by an independent, third-party and readings must be taken immediately upstream and downstream of the Air Cleaning system over at least a 24-hour period.
- D. Construction: The Air Cleaner modules shall consist of four or six individual Air Cleaner Panels that are nominally 1" in depth, arranged in V's within the module. The construction of the Air Cleaner frame and screens shall be aluminum, and the module side panels and attachment flanges shall be of galvanized steel. The Air Cleaner modules and each component thereof must have a positive seal where necessary to prevent bypass of unfiltered air.
- E. Electronics: The high voltage powerheads shall require 24 volts AC input and have a 9.5kV DC output. The powerheads must be fully potted and connected in parallel.

- F. Control Panel: The 24VAC power supply must be a UL or CSA certified transformer, class "2" type, which shall permit one side of the secondary output (24V) to be attached to electrical ground. A Filter Minihelic gauge shall be installed in the Unit Control Panel (optional direct readout or signal tied into building automation).
- G. Filter Media: Each Air Cleaner shall have a disposable and recyclable media pad with a minimum of a class "2" fire rating. It shall have a positive seal in the overall filter assembly.
- H. Configuration: The Air Cleaners will be arranged in pre-fabricated module assemblies nominally 12" or 18" in height, of varying widths up to 48", and 24" in depth in direction of airflow. The number of modules and width shall be such that the face velocity thru the filter bank shall be no more than 550 fpm. Dynamic. Provide side or face load configuration system as indicated on air handler schedule. Minimum requirements: 24" doors/access panels on both sides of filter section and 25" unobstructed upstream/downstream space in the filter section.
- I. Electrical Connection: The Air handler manufacturer shall provide a fully operational filter section for field connection and field electrical tie-in. All 24VAC electrical and control wiring integral to the Air Cleaner modules and Control Panel, including the access door interlocks, are to be provided by the Air Cleaner manufacturer for connection in the field or factory. All line voltage connections and wiring are the responsibility of the contractor.
- J. Maximum Allowable Static Pressure: To minimize energy consumption, the AHU fan system has been designed for specific pressure drop through the Air Cleaning system. The fan system is designed for a maximum of 0.75" w.g when the filters are dirty.
- K. Construction and Start-up: If the AHU is operating during construction, the Air Cleaner bank shall be protected using roll or other media. These should be removed after 30 days from initial startup.
- L. Replacement Media (optional): The AHU manufacturer is responsible to purchase and store sufficient replacement filters so as not to exceed a total static pressure of 0.75" w.g (Matching #11 above) for a period of 4 years from final acceptance. Material responsibility not to exceed total media changes of 6 times per year.
- M. Manufacturer: Dynamic Air Quality Solutions Model V8 Air Cleaning System or equal.

2.22 GAS AND VAPOR PHASE CONTROL MEDIA AND TRAYS

- A. Activated Carbon Media
 1. HVAC grade virgin carbon granules, 4 x 6 mesh.
 2. Carbon tetrachloride (CTC) activity of 60, minimum, with a ball abrasion hardness of 95 minimum per ASTM D-380.
 3. Ash content - 5% maximum per ASTM D-2866.
 4. Moisture content - 5% maximum by weight.
 5. Bulk density - .50 - .54 g/ml (31-34 #/cu. ft.) as packed.
 6. Media shall be loaded into trays by the vendor, but shall not be installed until immediately prior to beneficial occupancy and all paints and cleaning solvents are dry.
- B. Odoroxidant Media

1. Impregnated activated alumina media with a U.L. Class 1 rating designed to remove gaseous vapors such as H₂S, SO₂, SO₃, Ethylene (Olefins), Formaldehyde and Methy/Ethyl Mercaptans. It also has the ability to adsorb and absorb products of Aldehydes, light organic vapors, organic acids and inorganic acids.
2. Physical properties:
 - a. Built in color indicator Purple
 - b. Shape Spherical
 - c. Mean Particle Diameter 1/8" - 3/16"
 - d. Moisture, Maximum 15% w/w
 - e. Bulk Density 50 lbs/ft
 - f. Active Ingredients Potassium Permanganate (KMnO₄), 4% by weight,
 - g. Inert Ingredients Alumina (Al₂O₃)
 - h. U.L. Class 1 Rating Yes
3. Manufacturer: Unisorb Mark 2 or equal.

C. Media Trays

1. Constructed of non-corrosive high impact polystyrene with internal separators and filled with HVAC grade virgin carbon media.
2. Capable of being reloaded with fresh carbon in the field.

2.23 BUBBLE-TIGHT ISOLATION DAMPER

- A. Dampers shall be butterfly type consisting of circular blade, mounted to axle within formed flanged frame.
- B. Frame shall be constructed of steel channel with a clean and smooth interior surface.
- C. Blade shall be minimum 1/4-inch thick and be complete with full circumference silicone blade seal mechanically attached to blade with full circumference retainer ring. Adhesive seals are not acceptable.
- D. The axle shall be supported in sealed, relubricable, ball bearings mounted outboard of frame and be complete with axle shaft seals. Damper shall be actuated by external hand wheel gear operator, where indicated as manual type on drawings. For dampers serving the Damper frame and blade shall be fabricated from hot rolled steel.
- E. All parts not otherwise protected shall be given one coat of epoxy- polyamide coating.
- F. Dampers shall be designed and tested for bubble-tight leakage performance at the specified design pressure.
- G. Each damper shall be individually tested for leakage in conformance to AMCA Standard 500-D-98.

- H. Provide electric damper motors where motorized damper control is indicated on drawings. Damper motors to be 120 volts. "Fast acting" electric damper motors are required and able to close damper in one (1) second. Electric rotary actuator to have high torque, integral single phase, reversible, capacitor run motors and equipped with factory set travel limit switches, and motor brake. Damper motor to have auxiliary contacts for digital I/O signal from building direct digital control system.
- I. Manufacturer/model: Flanders #DBT-E-316/304-xx (sized to match duct diameter per drawings), Ruskin, Camfill, or equal.

PART 3 EXECUTION

3.01 TEMPORARY AND CONSTRUCTION FILTERS

- A. Provide temporary filters, pre-filters and high efficiency filters, for use in filter banks during the construction period. If excessive dust, dirt and debris are encountered during the construction period the contractor shall replace the temporary filters at no additional cost to the Owner. At no time during the construction period are systems to be operated without pre-filters and final filters in place.
- B. The Contractor shall provide continuous maintenance of the temporary filters in all units during the entire construction, start-up, testing, and final acceptance activities. The Contractor shall provide additional temporary filters as necessary to facilitate completion of all start-up, testing and commissioning activities.
- C. Contractor Option: Protect all 40% or higher efficient filters upstream of air handling units during construction with temporary blankets of 1/2" MERV-7 polyester or fiberglass filter media or 2" disposable panel filters, U.L. Class 2 listed. Remove prior to air balancing and prior to acceptance. Replace any dirty filters that were not adequately protected during construction.

3.02 FILTER FRAME INSTALLATION

- A. Install filter banks and holding frames leak tight and structurally sound to eliminate air bypass.
- B. Filter banks three filters high or higher: provide 3" wide 16-gauge galvanized or stainless steel stiffeners between each vertical row of filters. Caulk frames before installing. After installation caulk any gaps appearing at the leading edge of the holding frames. Use DAP "Butyl Gutter and Lap Sealer." After erection of the filter bank and caulking, tape the joints between filter frames on the downstream side with aluminum foil duct tape.
- C. HEPA filter frames over 6" deep do not require stiffeners, only taping and caulking. HEPA filter frames must be bolted together; welding will not be acceptable.
- D. Framing modules require sealant and stiffening only between modules and around the periphery.

3.03 FILTER INSTALLATION AND EXECUTION

- A. Install filter frames according to manufacturer's written instructions.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

- C. The appropriate fastener, as recommended by the manufacturer, shall secure each filter at its corner with a minimum four (4) fasteners per filter.
- D. Install filters in position to prevent passage of unfiltered air.
- E. Install filter gage for each filter bank, including pre-filters, final filters and HEPA filters.
- F. Install filter gage static-pressure taps upstream and downstream of filters to measure pressure drop through the filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. One gage may be used where filters are mounted immediately adjacent without intervening clear space. Adjust and level inclined gages.
- G. Coordinate filter installations with duct and air-handling unit installations.
- H. Electrical wiring and connections are specified in Division 26 Specification Sections.
- I. Ground equipment according to Division 26 Section - Grounding and Bonding for Electrical Systems.

3.04 FIELD QUALITY CONTROL

- A. Filter cartridges shall be capable of easily being loaded and unloaded through access doors in the housings or access sections.

3.05 START-UP PROCEDURE

- A. No fan shall be operated unless all particulate filters as specified (except gas phase filters) are installed, along with temporary pre-filter media.
- B. When the pressure drop of the temporary media reaches 0.5" W.G. during construction, replace it with the spare set. If not used, deliver the spare set to the owner at job completion.
- C. Gas phase carbon trays shall not be installed until just prior to beneficial occupancy and all paint is dry and cleaning solvents are completely evaporated. Test and balance contractor shall allow for resistance of carbon trays in his work by simulating their resistance on the system.

3.06 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

3.07 SPARE FILTERS

- A. Furnish one new complete spare set of filter cartridges for each filter bank listed below on completion and acceptance of the work:
 - 1. Medium and high efficient bag filters.
 - 2. Medium and high efficient rigid filters.
 - 3. DOP-rated 95% and HEPA filters.
- B. Final air balancing shall be performed with clean filters in place. If temporary construction filters are clean, as determined by test and balance agency, these temporary filters may be used for final balancing. Install final spare sets of filters only if, and when, directed by Owner's Representative. If not installed, deliver to Owner's Representative in sealed carton.

- C. Replace all panel filters which are not temporary pre-filters with a new set at job completion and furnish Owner's Representative with an additional set in sealed cartons.
- D. Furnish owner with one set of spare trays loaded with carbon, if carbon housings or adsorbers are specified on this project.

END OF SECTION

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SECTION 23 44 00

UV COIL IRRADIATION

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the following:
 - 1. System for UVC irradiation of cooling coil.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 01: General Requirements
 - 1. Section 01 91 13: General Commissioning Requirements
- B. Division 23: Mechanical
 - 1. Section 23 05 00 - Basic HVAC Materials and Methods
 - 2. Section 23 73 12 - Custom Factory Air Handling Unit
 - 3. Section 23 73 13 - Modular Air Handler

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
 - 2. Replacement parts shall be readily available and stocked in the USA.
- B. Independent testing: The unit shall be tested by an independent test laboratory and shall be verified to provide output per one-inch arc length of not less than 9 $\mu\text{W}/\text{cm}^2$ at one meter in a 400 fpm airstream of 50°F. Unit shall comply with ANSI/UL Standards 153, 1598, 1995, and CSA and CE standards. The manufacturer shall be an ISO 9001 certified facility.
- C. Codes and Standards:
 - 1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
 - 2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.

3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
5. All HVAC work shall comply with the Americans with Disabilities Act (ADA).

D. Product Control

1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
2. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
3. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
4. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for all lamps, fixtures, controls indicating dimensions.
- B. In order to guarantee the adequate coil treatment performance, the UVC vendor shall specify in detail, a manufacturer approved layout of the number of UVC sources required and their respective position (distance from the coil, alignment on the coil as well as on which side of the coil the UV source is to be installed).
- C. Maintenance Data: Submit maintenance instructions, including instructions for system upkeep, lamp replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

1.06 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Air handling units scheduled with UV coil treatment are to be equipped with ultraviolet chilled water coil irradiation system factory installed in the air handler using a custom configured rack design.
- B. The UVC Emitter, TM and fixture shall be factory assembled and tested. They shall consist of a fixture, power supply, reflector, emitter sockets and emitter, and monitoring.
- C. Preapproved manufacturers include SterilAire, UV Resources, Fresh Aire UV, Ultra Violet Devices Inc. (UVDI), Sanuvox, or equivalent.
- D. Performance Criteria:
1. To effectively irradiate the HVAC coil surface and maximize the UV irradiation onto the coil, each UVC lamp will be mounted to a ^{[[SEP]]}parabolic reflector made of aluminum, reflecting at least 90% of the UVC (254 nm) energy, optimizing the UVC output of the lamp onto the coil that will continuously clean the coil and drain pan, kill odor causing mold and fungus that may develop in an HVAC unit and keep the airflow through the coil at optimum to maximize energy efficiency
 2. Adequate performance is defined as the irradiation intensity required so that a microorganism requiring a lethal UV dose of 100,000 microwatts/cm² will not survive more than 60 minutes anywhere on the treated surface of the coil after 17,000 hours of operation. In order to validate the performance of the proposed arrangement, the vendor shall submit a manufacturer approved computer simulation showing the resulting microorganism kill (time map) of the treated surface of the coil after 17,000 hours of operation.
- E. Fixture Construction:
1. The fixture shall be constructed of 304 stainless steel to withstand HVAC environments.
 2. The reflector shall be constructed of heavy gauge, specular finished aluminum alloy with approximately 85% reflectance at 254 nm wavelength. The aluminum parabolic reflector will be built from an aluminum extrusion aerodynamically shaped to be capable of withstanding air velocities up to 2000 ft/min. without wobble, vibration or whistle noise.
 3. The housing shall be equipped with 1/2" electrical conduit opening/s on each end to facilitate wiring fixture-to-fixture coupling. All components shall be in one integral assembly to maximize serviceability.
- F. UVC Emitter Lamps and lamp sockets:
1. The Emitter sockets are medium bi-pin, double click safety, twist lock type. They shall be constructed of UVC-resistant polycarbonate.
 2. The Emitter shall be a very high output, hot cathode, T5 diameter, medium bi-pin type that produces germicidal UVC of 253.7 nm. The DE Emitter shall operate in air velocities of up to 2000 fpm and air temperatures of 35-140 °F. It shall produce no ozone or other secondary contaminants.
 3. The UVC net output directed at the coil will be at least 10 microwatts/cm² per inch of lamp at 1 meter (after Burn-In time) in the 245 nm to 266 nm. band while operating at nominal temperature in an air stream moving at 400 fpm.
- G. Electrical Requirements:

1. The power source will be an electronic type, rapid start with a power factor greater than 0.95 and an energy conversion of at least 75%. The power supply shall be a Class P2 with a power factor greater than 0.98 and a power conversion of greater than 90%. The power supply design shall include RF and EMI suppression. The power supply shall be designed to maximize photon production, irradiance and reliability in cold airstreams of 45-140 °F, 100% RH. The power supply shall be available in 110-277 V, 50/60 Hz, single phase.
 2. The ballast will be mounted in an adequate aluminum enclosure that will enable it to be mounted on a rigid surface outside of the AHU, protecting the power source from moisture and humidity.
 3. Safety interlock switches are to be installed on all access doors where UV intensity may be present. Manufacturer to provide CAUTION LABELS to be installed on these access doors.
- H. Monitoring: Install a monitoring system to provide indication of equipment status. Monitoring shall include dry contacts for interface with the BMS system and include at each Ballast Box an electronic device that will enable the monitoring of either 1 or 2 lamp fixtures including:
1. Lamp on indicator to insure that a lamp is functioning
 2. Lamp out indicator to warn if a lamp has failed.
 3. Lamp replacement indicator to notify that the lamp has reached its design performance specification (17,000 operating hours), and is due for replacement
- I. Warranty
1. The power source will carry a 15-year ballast warranty.
 2. The high intensity UVC lamp will be guaranteed for 17,000 hours.
 3. The control electronics (if supplied) will carry a 3-year warranty.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and electricians and shall result in an installation consistent with the best practices of trades.
- B. Each UVC source will be clamp-mounted for easy installation, positioning and maintenance onto standard 3/4-inch (1.87 cm) electrical conduit or aluminum tubing, supplied by the vendor or field supplied and installed as a permanent support structure. The support structure will be adequately fixed with non-corrosive hardware so that the UVC source does not vibrate or loosen.
- C. Mounting Location: According to the 2008 ASHRAE Handbook, HVAC Systems and Equipment, Chapter 16, titled Ultraviolet Lamp Systems, UVGI Systems can be installed Upstream or Downstream of the Cooling Coil. Both locations have advantages and disadvantages. The custom air handling unit manufacturer to coordinate with the supplier of UVC equipment to determine the best mounting location to facilitate protection of lamps, ease of maintenance, and maximum treatment benefit.

3.02 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturer's directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.03 INSTALLATION

- A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.
- B. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects.

END OF SECTION

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SECTION 23 52 00

NON-CONDENSING BOILERS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Hot Water Boiler (30 psi, 3 pass, Fire Tube)
 - 2. Hot Water Boiler (Cast Iron Section Type)
 - 3. Copper Fin Tube Hot Water Boiler
 - 4. Hot Water Boiler (Forced Draft Flexible Watertube Gas Fired HW)
 - 5. Commercial Pool Heater
 - 6. Boiler Sequence Control

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230716: Equipment Insulation
- D. Section 230900: Building Automation System (BAS) Controls
- E. Section 232113: Hydronic Piping, Valves and Specialties
- F. Section 232123: Hydronic Pumps
- G. Section 233113: Air Distribution
- H. Section 235220: Steam Boilers
- I. Section 238239: Heat Transfer
- J. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide boilers conforming to the requirements of the latest addition of the following:
 - 1. American Boiler Manufacturer's Association (ABMA) "Standard Test Procedure for Packaged Firetube Boilers". Label boiler with ABMA emblem on boiler nameplate.
 - 2. American National Standards Institute (ANSI):
 - a. B31.1 - Power Piping
 - b. Z21.13b – Gas-Fired Low-Pressure Steam and Hot Water Boilers
 - 3. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code
 - a. Section VIII D1 - Rules for Construction of Pressure Vessels including Addendums
 - b. Section VIII D2 - Rules for Construction of Pressure Vessels including Addendums
 - c. Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums
 - 4. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
 - 5. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 - 1. The proposed substitution does not affect dimensions shown on drawings.
 - 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 - 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 - 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.

- B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight loading, required clearances, methods of assembly of components, and location and size of each field connection.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.
- D. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.
- E. Boiler Certification: The boiler manufacturer shall submit evidence that the boiler(s) meet the requirements of the standards specified.
- F. Vent Manifolds Coordination: For boiler plant installation requiring multiple boilers venting into a common vent stack, provide vent submittal with sign-off by the submitted boiler manufacturer attesting to their approval of the proposed venting arrangement.
- G. Commissioning Test Plan: Submit test plan for boilers. Plan shall include test schedules, and names and titles of the test personnel who will be participating in the commissioning tests. The test personnel must be employees of the boiler manufacturer or the manufacturer's designated representatives. Plan shall include false loading of boilers, if the anticipated building loads at the time of test do not meet capacity requirements. Submittals shall have detailed layout for temporary equipment, if such equipment is needed, even if it is not specified or shown on the Drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. For multiple boiler installations with boilers vented to a common vent, the boilers shall be symmetrically air-fuel coupled such that any changes in the combustion air-flow or flue flows shall affect the BTUH input without affecting the combustion quality.

2.02 HOT WATER BOILER (30 PSI, 3 PASS, FIRE TUBE)

A. General:

1. Furnish and install, where shown on the plans, hot water boiler having the capacity and features detailed herein and scheduled on plans. Unit shall include burner for firing on [gas] [combination gas/No. 2 oil] [No. 2 oil]. The units shall be of the three-pass scotch design with water cooled rear combination chamber and two passes of fire tubes, and shall be constructed in accordance with the ASME Code for 30 lbs. water.
2. The unit(s) shall have a gross output rating as scheduled on plans. A refractory lined access opening with Pyrex observation port shall be provided to permit entry into the rear combustion chamber. Access to tube sheets and fire tubes for inspection or cleaning shall be provided without disconnecting any fuel piping or electrical wiring. Unit(s) shall be of gas tight construction throughout. Front flue doors shall be gas tight and lined with insulating refractory. Unit(s) shall be provided with lifting loops.
3. Unit(s) shall be provided with a factory installed enameled steel jacket insulated with mineral fiber insulation. Heavier insulation shall be installed at selected locations to provide additional protection of the jacket at potential external pressure points. Heavier insulation shall also be installed along the top length of the boiler at the centerline. Hand hole and washout openings shall be in accordance with the ASME Code requirements. Manhole (250-750 HP).
4. All tubes shall be set with roller expander at each end. Tubes shall not be welded to the tube sheets. Refractory baffling between passes will not be permitted.
5. Unit(s) shall be assembled and wired with burner, controls, trim and skid type base installed at the factory.

B. Standard Equipment:

1. Boiler trim shall consist of the following mounted, piped, and wired:
 - a. Relief valves
 - b. Low water cut off
 - c. Pressure gauge
 - d. Thermometer
 - e. Drain valve
 - f. Air flow safety switch
 - g. Flue gas thermometer
 - h. Flue damper
 - i. High limit controls
 - j. High-low-off firing sequence
 - k. Fuel-air and firing rate controls
 - l. Control cabinet
 - m. Low fire hold aquastat

C. Burner and Associated Equipment:

1. Fuel burning equipment shall be forced draft type, factory assembled, wired, mounted, and tested. The entire unit shall bear the Underwriter's Laboratories label and shall be ready for field connection to power and fuel supply. Equipment shall include: forced draft fan with air NEMA-1A control cabinet containing electronic flame safeguard and programmer, control circuit switch, necessary switching relays, indicating lights for major operations, numbered terminal strip, numbered wiring, engraved nameplates.
2. All motors shall be for ____ volts, ____ hertz, (one) (three) phase operation. Controls shall be 115 volt, 60 hertz, single phase. Necessary fuses, motor contactor or magnetic motor starters with thermal overload protection, and a step-down control circuit transformer shall be provided with the control cabinet.
3. Fuel burning equipment shall be set and adjusted by a factory authorized representative to burn ____ G.P.H. of No. (2) (4) (5) (6) oil (and) (or) ____ C.F.H. of having a ____ sp. gr. with ____ in W.C. pressure at inlet of burner manual gas cock. Unit efficiency based on flue gas analysis, shall be not less than 80%.
4. Owner's representative shall be present to receive instructions in care and maintenance of the unit(s) at the time it is started up by the service representative.
5. Gas Units (20-750 HP):
 - a. Gas burners shall be of the (flange mounted 20-250) (base mounted 300-750) annular port flame retention type including a main gas control group consisting of [safety gas valve (20-50)] [motorized gas valve with proof of closure (60-100)] [two motorized gas valves, one with proof of closure (125-750)]; gas volume control valve with adjustable cam operator (100-750); gas pressure regulator; gas gauge; and [one gas cock (20-50)] [two lubricated plug cocks (60-750)]; high and low gas pressure interlocks (60-750); normally open vent valve (300-750); provision for pressure check (20-750); gas-electric ignition assembly consisting of a pilot burner, 6,000 volt ignition transformer, unitized safety gas valve, gas pressure regulator and gas cock.
 - b. Controls to include air flow safety switch, ultra-violet flame detector, low fire interlock (60-750), and all necessary controls and linkage for [on-off (20-50)] [two position with proved low fire start (60-80)] [modulated with low fire start (100-750)].
 - c. Fuel air control shall provide [two position (60-80)] regulation of the air damper and the gas volume control valve by means of a [damper motor (60-80)] [modutrol motor (100-750)].
 - d. Provide Fireye fault indicator Model 53SE2 mounted on burner control panel.]
6. Combination Gas-Pressure Atomizing Oil Units (20-400 HP):
 - a. Gas-oil burner shall consist of a [flange mounted (20-250)] [base mounted (300-400)] combination annular port flame retention type gas burner and mechanical pressure atomizing oil burner for No. 2 oil. Gas side shall include necessary controls for [on-off firing (20-50)] [two position firing with proved low fire start (60-80)] [modulated firing with proved low fire start (100-400)]. Oil side shall include necessary controls for [on-off firing (20)] [on-off firing with low fire start (30-50)] [two position firing with proved low fire start (60-80)] [modulated firing with proved low fire start (100-400)].
 - b. Gas controls shall include a main gas control group consisting of {[one safety gas valve (20-50)] [one motorized gas valve with proof of closure (125-400)]; gas volume control valve with adjustable cam operator (100-400); gas pressure regulator, gas gauge and [one gas cock (20-50)] [two lubricated plug cocks (60-400)]; high and low gas pressure interlocks (60-400); normally open vent valve (300-400); gas gauge; provision for pressure check (20-400)]; {Standard IRI gas train}.

- c. Oil controls shall include a [two state oil pump mounted on burner (20-125)] [two stage separate oil pump assembly mounted on boiler skid (150)] [one stage separate oil pump assembly mounted on boiler skid (200-400)] [one atomizing oil nozzle (20-30)] [three atomizing oil nozzles (40-400)]; oil solenoid valve(s); oil filter, oil metering control valve with adjustable cam operator (100-400).
- d. Controls for both fuels shall include an ultra-violet flame detector; air flow safety switch and [direct spark ignition with 10,000 volt ignition transformer (oil units 20-50)] [gas-electric ignition assembly consisting of a pilot burner, 6,000 volt ignition transformer, unitized safety gas valve, gas pressure regulator and gas cock (gas 20-400) (oil units 60-400)].
- e. Fuel-air control shall provide [two position (60-80)] [modutrol motor (100-400)]. Fuel regulation of the oil metering control valve shall be by modutrol motor (100-400).
- f. Changeover from one fuel to the other shall be accomplished by means of a manual fuel selector switch in the control cabinet. No changes in linkage, burner position or mechanical adjustment shall be necessary when changing fuels. The fuel selector switch shall provide, through the combustion control relay, proper ignition timing for the fuel being burned.
- g. Provide fireye fault indicator Model 53SE2 mounted on burner control panel].

D. Manufacturer: Cleaver Brooks, Burnham Series 3.

2.03 HOT WATER BOILER (CAST IRON SECTIONAL TYPE)

A. General:

1. Furnish and install, where shown on the plans, hot water boiler having the capacity and features detailed herein and scheduled on plans. Unit shall include burner for firing on gas. The units shall be of the sectional cast iron type and shall be constructed in accordance with the ASME Code for 30 lbs. water.
2. Port openings to have elastomer sealing rings. Sections to have aligning lugs and sockets to assure proper section alignment of port openings.
3. Unit to have water backed combustion area with water circulation completely around fire box.
4. Unit to have cast iron flue collar with built-breeching damper.
5. Provide unit with burner mounting plate with refractory, aluminized steel gas collector, observation ports on front and back section, side cleanouts plates, 60 psi ASME safety relief valve, combination high limit and low limit controls, combination pressure temperature gauge and built-in air eliminator.

B. Jacket and Insulation:

1. Unit to have steel jacket with powder-coat finish.
2. Unit to be completely insulated.

C. Standard Equipment:

1. Boiler trim shall consist of the following mounted, piped, and wired:
 - a. Relief valves
 - b. Low water cut off
 - c. Pressure gauge

- d. Thermometer
- e. Drain valve
- f. Air flow safety switch
- g. Flue gas thermometer
- h. Flue damper
- i. High limit controls
- j. High-low-off firing sequence
- k. Fuel-air and firing rate controls
- l. Control cabinet
- m. Building Control System interface including contacts for start/stop, on/off status, and indication of alarm.
- n. Low fire hold aquastat
- o. CSD-1 Approved Valves and Controls

D. Burner and Associated Equipment:

1. Fuel burning equipment shall be forced draft type, factory assembled, wired, mounted, and tested. The entire unit shall bear the Underwriter's Laboratories label and shall be ready for field connection to power and fuel supply. Equipment shall include: forced draft fan with air NEMA-1A control cabinet containing electronic flame safeguard and programmer, control circuit switch, necessary switching relays, indicating lights for major operations, numbered terminal strip, numbered wiring, engraved nameplates.
2. All motors shall be for 120 volts, 60 hertz, (one) phase operation. Controls shall be 115 volt, 60 hertz, single phase. Necessary fuses, motor contactor or magnetic motor starters with thermal overload protection, and a step-down control circuit transformer shall be provided with the control cabinet.
3. Fuel burning equipment shall be set and adjusted by a factory authorized representative to burn 641 C.F.H. of gas having a 0.60 sp. gr. with 5.7 in W.C. pressure at inlet of burner manual gas cock. Unit efficiency based on flue gas analysis, shall be not less than 80%.
4. Owner's representative shall be present to receive instructions in care and maintenance of the unit(s) at the time it is started up by the service representative.
5. Gas burners shall be of the flange mounted annular port flame retention type including a main gas control group consisting of safety gas valve; gas pressure regulator; gas gauge; and one gas cock; gas-electric ignition assembly consisting of a pilot burner, 6,000 volt ignition transformer, unitized safety gas valve, gas pressure regulator and gas cock.
6. Controls to include air flow safety switch, ultra-violet flame detector, and all necessary controls and linkage for on-off.

E. Manufacturer: Weil-Mclain as specified or approved equal by Burnham or Smith.

2.04 COPPER FIN TUBE HOT WATER BOILER

- A. General: Factory packaged unit shall include boiler, burner, painted steel jacket, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of A.G.A. and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the schedule data sheet. A certified factory fire-test shall be provided with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for 160 PSIG water in accordance with Section IV of ASME Code. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements. Unit(s) shall be a minimum of 85% Thermal efficiency and shall be non-condensing.
- B. Boiler Type: Vertical copper water tube with straight $\frac{1}{2}$ " I.D. finned copper tubes rolled into top and bottom headers. Tubers shall be intermeshed for maximum heat transfer and shall be warranted ten (10) years against thermal shock.
1. Combustion chamber shall be 16-gauge and constructed of corrosion resistant aluminum. It shall be enclosed in an air tight 14-gauge steel outer cabinet with an insulating air space between the combustion chamber and outer cabinet. The outer cabinet shall be finished on both sides with a baked epoxy finish. A glass sight port shall be provided for burner observation.
- C. Boiler Trim: Shall be as follows:
1. Combination temperature/pressure gauge.
 2. ASME rated water relief valve.
 3. Low water cut-off.
 4. Water flow switch.
 5. Drain valve.
 6. Operating controller.
 7. Limit control with manual reset.
 8. Fuel-air controller (as required).
 9. Barometric damper.
- D. Burner Type: Power type radial fired with screen type diffuser for full 360° flame pattern. To include blower assembly and fuel-air mixture assembly controlled by multiple calibrated brass orifices and venturi core to measure air flow to burner. Orifices and venturi core removable without removing burner from boiler. Air flow switch.
- E. Gas Burner: Minimum pilot safety burner shall consist of gas-electric spark ignition with 100% safety shut-off pilot, solenoid gas valve, pressure regulator and shut-off cock. Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual safety gas valves, manual test valve high-low pressure switches and manifold pressure gauge. Gas train shall be factory packaged to meet insurance requirements as indicated.
- F. Control Panel: NEMA 1 enclosure mounted on boiler. Power source to be 120V/60H/1P. Components to include blower motor contactor; Honeywell R 895C flame safeguard and program controller; diagnostic annunciator to include lights for power on, load demand, ignition, pilot, main flame, low water, low gas pressure, low combustion air, high water temperature and flame failure; relays as required and terminal strip
- G. Manufacturer: Thermal Solutions Evolution, Harsco Patterson-Kelly PK Thermific Velox, Hamilton 88.

2.05 HOT WATER BOILER (FORCED DRAFT FLEXIBLE WATERTUBE GAS FIRED HW)

A. General:

1. Furnish and install, where shown on the plans, hot water boiler having the capacity and features detailed herein and scheduled on plans. Unit shall include forced draft reduced Nox burner for firing on combination gas/No. 2 oil. The unit shall be of the water tube design and shall be constructed in accordance with the ASME Heating Boiler Code, Section IV, and shall bear the ASME "H" Stamp for a maximum working pressure of 125 psig.
2. Accepted manufacturers are Bryan, Cleaver-Brooks, or Unilux.
3. The Boiler shell shall be constructed of welded steel boiler plate. Boiler shall be constructed with adequately sized upper drums, water legs and tube headers, providing proper internal thermal water circulation, not requiring an external circulation source. Water tubes are to be 1 1/2" O.D., 12 gauge steel, four-pass, flexible serpentine bend design, not subject to thermal shock damage. Individual water tubes shall be easily removable and replaceable without either welding or rolling. Entry into combustion chamber or major disassembly of the jacket shall not be required to remove or replace tubes.
4. The boiler shall be constructed and assembled as a completely packaged unit.
5. The boiler shall have no less than 5 sq.ft. Of heating surface per boiler horsepower. (6,695 BTU per sq.ft.)
6. The Unit shall be provided with a factory installed galvanized and painted steel jacket designed with air separation insulation.
7. Unit shall be assembled and wired with burner, controls, trim and skid type base installed at the factory.
8. Boiler shall be built with an integrated extended surface heat extractor and guaranteed for 80% combustion efficiency.

B. Combustion Chamber and Flueways

1. Access: A hinged access door shall be provided near the front of the boiler to provide an access opening of not less than 20" wide by 30" high, for full access to the combustion chamber and burner head. Remaining panels shall be individually removable. All access panels shall be affixed to the pressure vessel frame, full gasketed for pressurized firing.
2. Pressurization: The boiler combustion chamber and flueways shall be designed to operate at an overfire pressure of up to 2" w.c.
3. Welded Construction: All joints of the flue-gas containing section shall be fully seal welded, except for the pressure-tight gasketed panels on the access side.
4. Insulation: All interior walls of the flue-gas containing section shall be lined with high temperature insulation. The floor beneath the tubes shall be lined with insulating refractory and mineral fiber back-up insulation. The boiler shall be warranted for 20 years against thermal shock on a non-pro-rated basis.
5. Jacket: The boiler shall be complete with an insulated metal jacket consisting of:
 - a. Structural steel frame.
 - b. Heavy gauge, zinc-coated rust resistant steel casing, painted with a suitable primer and enamel.
 - c. Individually removable access doors, with handles providing easy access to combustion chamber and tube access panels.

C. Burner and Associated Equipment:

1. Fuel burning equipment shall be forced draft type, modulating, factory assembled, wired, mounted, and tested. The entire unit shall bear the Underwriter's Laboratories label and shall be ready for field connection to power and fuel supply. Equipment shall include: forced draft fan with air NEMA-1A control cabinet containing electronic flame safeguard and programmer, control circuit switch, necessary switching relays, indicating lights for major operations, numbered terminal strip, numbered wiring, engraved nameplates. Burner shall be capable of internal controlled Nox not to exceed 30 ppm at 3% O₂.
2. All motors shall be for 460 volts, 60 hertz, three phase operation. Controls shall be 115 volt, 60 hertz, single phase. Necessary fuses, motor contactor or magnetic motor starters with thermal overload protection, and a step-down control circuit transformer shall be provided with the control cabinet.
3. Fuel burning equipment shall be set and adjusted by a factory authorized representative to burn No. 2 oil and natural gas. In the oil fired mode the burner shall be capable of a 3:1 turndown ratio. In the gas fired mode the burner shall be capable of operating with a 4:1 turndown ratio. In the gas fired mode, the burner shall control excess air for a constant 15% over the entire firing range. Changeover between oil and gas firing is to be accomplished without the need for any manual burner or nozzle adjustment or modification. Integrally mounted oil pump is to be automatically decoupled from operation when gas burner is operating. Alternately, an external oil pump package is to be provided complete with all controls for interface with the burner. Provide necessary auxiliary contacts for wiring to Facility EMS system for remote fuel changeover.
4. Owner's representative shall be present to receive instructions in care and maintenance of the unit(s) at the time it is started up by the service representative.
5. Burner manufacturer is to be Weishaupt, Gordon-Piatt.

D. Boiler trim shall consist of the following mounted, piped, and wired:

1. ASME Relief valves
2. Pressure gauge
3. Thermometer
4. Drain valve
5. Water temp. control aquastat
6. CSD-1 Approved Valves and Controls
7. Manual reset type low water cutoff
8. Manual Reset High limit controls
9. Control cabinet
10. Multiple boiler sequencing controls.
11. Gas train components for each boiler shall comply with factory mutual requirements and as a minimum, shall be as follows:
 - a. Automatic gas valve operator.
 - b. Auxiliary safety shut-off valve.
 - c. Pilot solenoid valve.
 - d. Electric spark ignition assembly with 100 percent
 - e. safety shut-off pilot.

- f. Main manual gas shut-off valve.
- g. Pilot cock
- h. Pilot and main gas pressure regulators.
- i. Air safety switch.
- j. Electronic combustion safety control with UV sensor.
- k. Low water cut-off
- l. High/Low gas pressure switches for fuel pressure supervision.
- m. Shutdown on high or low gas pressure.

E. Indirect Heat Exchanger (For domestic water heating units):

- 1. Each boiler selected for domestic water heating application shall be equipped with double walled indirect heat exchangers with a capacity as listed on drawings.
- 2. Construction to be of heavy copper seamless tubing attached to brass heads. Unit to be hydrostatically tested at 200 psi.
- 3. Heat exchangers are to be attached to boiler shell by means of a gasket and stud type connection and shall be easily removable and replaceable.

2.06 COMMERCIAL POOL HEATER

- A. General: Factory packaged unit shall include burner, integral heat exchanger, painted steel jacket, controls and accessories all piped and wired for single point field connections. Units shall carry packaged label of A.G.A. and be in accordance with ASME/CSD-1, all codes required by the local governing authorities and as indicated on the schedule data sheet. A certified factory fire-test shall be provided with data sheets furnished to Engineer and Owner. ASME certified, labeled, stamped and designed for 160 psig water in accordance with Section IV of ASME Code. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements. Unit(s) shall be a minimum of 80% Thermal efficiency and shall be non-condensing.
- B. Manufacturer: Laars Pennant-PNCP, Raypak, Lochinvar Aquas.
- C. Heater Type: Heater shall be a unit designed specifically for swimming pool heating applications and specifically designated as such by the manufacturer. The heater shall be atmospheric type using titanium stainless steel burners. It shall not require blower motors to supply combustion air or to create venting action. The fuel-air mixture shall be factory set for maximum combustion efficiency and shall be tamperproof in the field
- D. Heat Exchanger:
 - 1. The pool heater shall be of the straight tube design and shall have no blind passages or concealed pockets in the water containing section. The heater shall be fitted with a built-in automatic flow control device which shall maintain a constant water velocity over all direct fired heating surfaces to prevent lime formation in the heater over a wide range of filter flow rates.
 - 2. Inspection covers permitting complete visual inspection and cleaning of all wet internal surfaces shall be provided on headers at each end and held in place by heat treated corrosion resistant steel cap screws. All waterways shall be copper or bear fused ceramic coating to positively protect the boiler from corrosion.
 - 3. The entire wet section of the heater shall be removable and replaceable without damage or disassembly of combustion chamber and/or burner sections.

4. The water tubes shall be made of integral-finned copper tubing of 7/8" ID x 0.065 wall thickness with fins of 0.40" minimum height spaced at 7 fins per inch. The tubes shall be rolled directly into an ASME header of gray cast iron protected by a ceramic coating fused into the metal at not less than 1,100° F. Non-metallic gaskets shall be exterior to the jacket structure and combustion chamber to avoid deterioration from overheating. The complete heat transfer section shall be hydrostatically tested at 400 psi, be ASME inspected and approved, and protected by an ASME pressure relief valve set to 75 psi.
- E. Combustion Chamber and Jacket: Chamber to be lined with a castable refractory approved for temperatures at not less than 2,100 °F. The outer jacket shall be unitized shell and frame construction fabricated of galvanized steel and finished with acrylic epoxy baked at not less than 400°F.
- F. Controls: The heater shall be factory equipped with low voltage 24 volt controls as follows:
 1. Solid state electronic pilot flame supervision to de-energize main burner controls within one second of a pilot failure
 2. Close differential aquastat specifically designed for swimming pool control
 3. High temperature limit control
 4. Pressure flow switch
 5. 24 volt control transformer
 6. Automatic electric pilot ignition (gas only).

2.07 BOILER SEQUENCE CONTROL

- A. General: Provide, as part of the boiler control system, a separate microprocessor based lead-lag sequencing system for the heating hot water boilers and the indirect domestic water boilers. The control shall be pre-engineered and programmed exclusively for the operation of multiple hot water full modulation boilers. The control shall provide an on-off and 135 ohm modulation signal to each boiler to maintain a desired header supply water temperature.
- B. Setpoint: The control shall accept a 4-20 mA input for remote setpoint adjustment from building EMCS control system for outside air reset adjustment. The 4-20 mA input shall correspond to a 140 to 200 degree supply boiler water temperature to prevent boilers from operating outside their safe operating range.
- C. Digital Display: The control shall provide an L.E.D. "Bar Graph" display of each boilers approximate percent modulation. The control shall also provide a red L.E.D. display of header water temperature, setpoint, gain adjustment and each boilers exact percent modulation. In addition, the digital display shall be used to indicate the following settings as they are being adjusted:
 1. Ignition Start Point: Adjustable from 0-50% to determine the percent modulation a stage must achieve before the next stage is activated. There shall be an independent adjustment of this setting for each burner.
 2. Purge Timer: Adjustable from zero to 10 minutes to determine the delay time between a burner being energized and the beginning of modulation.
 3. Lag Boiler Start Timer: Adjustable from one to 60 minutes to delay starting of lag boiler after being called. This allows the lead boiler to catch the load and avoid unnecessary boiler cycling.
 4. Additional Indications: Indicator lights shall be provided to indicate the lead boiler selected and all activated stages.

5. Control Switches: Each boiler shall have an “On-Auto-Off-Stand By” control switch for control or isolation of individual boilers. An additional “Lead Boiler” selection switch shall be provided for automatic or manual lead boiler selection.
6. Sensor: Temperature sensor shall be low cost thermistor type, provided with immersion well and electrical junction box for header mounting in ½” NPT tapping.
7. Battery Back-Up: A lithium battery shall be included to maintain all setpoints in the event of power failure.
8. Remote Intercept: The control shall have the capability of being field upgraded to allow for remote communication. Communication shall be via standard telephone lines, RS232 or RS485. No external components shall be required for remote communication. Access to the control shall be via a dumb terminal or personal computer. No proprietary software shall be required.
9. Sequence of Operation: Initiation of boiler operation shall occur after proof of heating water demand has been occurred in the building. In general, a minimum of three heating water valves shall open on call for heating before operating the boiler sequencing. On a drop in system temperature the lead boiler will be energized. After an adjustable time delay, to allow the boilers firing sequence to elapse, the control shall begin modulating the lead burner upward from the ignition startpoint at a rate proportional to the system temperature rate-of-change and the “gain” setting. At a field selected percent modulation start point, if more capacity is required, the next stage will be energized after the lag boiler start time delay, and proceed according to the system rate-of-change and “gain setting”. Additional stages will be added as required and controlled in a similar manner. As system temperature or pressure rises, the control will decrease the modulation of the last boiler on line so as not to over shoot the set point. Once a boiler has been modulated down to its' ignition start point, it will be held there while the previous stage's modulation is reduced. The last boiler on line will not be de-energized until the previous stage's modulation has dropped below its modulation start point. Additional stages will be controlled and de-energized in a similar manner as required.
10. Domestic hot water operations: Similar to above, except, the system will sense storage tank temperature as the primary controlled variable. For each boiler brought on line start the associated circulating pump between the boiler and the storage tank.
11. Alarm Contacts: Provide alarm status contacts for each boiler for remote annunciation to building EMS system.
12. Boiler Monitoring: Provide integral to panel a Honeywell Keypad Display Module (S7800A1001) to interface to boiler flame safeguard for burner status and trouble shooting. A common display may be used with a selector switch to select which boiler to monitor.
13. Enclosure: A wall mounted, NEMA Type 12 or better enclosure shall be provided. Enclosure shall incorporate a window to allow full view of all digital and lamp indications without opening panel door.
14. U.L. Listing: Control panel shall be U.L. listed and labeled as an industrial control panel as a complete system.

2.08 EMERGENCY SHUTDOWN SWITCH

- A. Emergency boiler room shutdown switch for mounting outside boiler room doors. Mechanical to provide and install for complete and operational system per ASME CDS-1. Switch shall work independently of Building Automation System. Features shall include:
 1. Emergency off push button. Button shall be red with white lettering. 1-1/2” diameter. Button type shall include latching action upon activation. Button type shall be “turn-to-reset” after a boiler incident has been resolved.

2. Housing: Polycarbonate or metal for recessed wall installation. Cover shall be clear and hinged to protect button from accidental activation.
 3. Output: SPDT relay for 120-240 V AC service.
 4. Operating Temperature Range: -40°F to 250 °F.
 5. Mounting: Located switch at 48" above finished floor in compliance with ADA.
- B. Signage: Mount aluminum or plastic warning sign above switch. Sign shall be minimum 7" wide by 5" tall with red background and white lettering. Text of sign shall be "BOILER EMERGENCY SHUTOFF".
- C. Switch Manufacturers: Safety Technology International #Stopper Station Series.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
 2. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. All equipment, unless otherwise shown or noted, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Boilers are to be installed on concrete housekeeping pads. Provide manufacturer and code clearance all around and provide minimum 48" clearance between boilers.
- C. Install boiler trim not installed at factory.
- D. Connect to supply and return water piping, natural gas/fuel piping, flue vent, combustion air duct and relief piping.
- E. Relief valves are to be piped and terminated 1" above approved termination location.
- F. Flush and clean boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls
- G. Hydrostatically test assembled boiler(s) and piping in accordance with applicable sections of ASME "Boiler and Pressure Vessel Code".
- H. Arrange for inspection of boiler and piping, observation of hydrostatic testing, and for certification of completed boiler units by an authorized inspector in accordance with NBBPVI NB23. Provide all scaffolding, ladders, opening of vessels, filling, draining, lights, closing of vessels and services to support the authorized inspector.

- I. PH Neutralizers are to be piped with PVC tubing. All piping to be per manufacturer's diagrams and instructions. Neutralizer tube to be secured to floor or wall out of normal walking path. The tubes and p-traps are to be filled with water before firing any boiler. Neutralizer tube to be charged prior to installation and a minimum of material for one recharge to be supplied.

3.03 EMERGENCY BOILER SHUTDOWN

- A. All automatically fired boilers with input greater than 400,000 Btuh shall have a manually operated remote shutdown switch to shutdown boiler(s) and associated equipment. Activation of the emergency shutdown switch shall immediately shut off the fuel or energy supply and initiate the boiler shutdown sequence in accordance with manufacturer's recommendations where applicable.
- B. The shutdown switch should be located just outside the boiler room door and marked with signage for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.
- C. Comply with local building and mechanical codes for additional requirements. Comply with ASME CDS-1 and ASME Boiler and Pressure Vessel Code (BPVC) Section HG-634.
- D. Provide conduit, wiring, relays, devices, etc., as required for complete and operational emergency shutdown system including shutdown of boiler(s) and associated pump(s) and valve(s) as necessary. Coordinate with electrical design as necessary. Shutdown system shall operate independently of BAS, but BAS should monitor activation of switch for remote indication. Coordinate with BAS contractor for interface.

3.04 CONNECTIONS PIPING INSTALLATION REQUIREMENTS ARE SPECIFIED IN OTHER DIVISION 23 SECTIONS. DRAWINGS INDICATE GENERAL ARRANGEMENT OF PIPING, FITTINGS, AND SPECIALTIES.

- A. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 230500 "Basic HVAC Materials and Methods."
- B. Connect gas piping full size to boiler gas-train inlet with union.
- C. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- D. Install piping from safety relief valves to nearest floor drain, floor sink or other approved location.
- E. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- F. Connect breeching full size to boiler outlet.
- G. Install piping adjacent to boiler to allow service and maintenance.
- H. Ground equipment according to Section 260526 "Grounding and Bonding."
- I. Connect wiring according to Section 260519 " Low-Voltage Electrical Power Conductors and Cables."

- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service.
- B. Perform installation and startup checks according to manufacturer's written instructions.
- C. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- D. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Adjust initial temperature set points.
- G. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.
- I. Prepare written report that documents testing procedures and results.

3.06 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify boiler mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 52 13
ELECTRIC BOILERS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Electric Hot Water Boilers
 - 2. Boiler trim and accessories

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230716: Equipment Insulation
- D. Section 230900: Building Automation System (BAS) Controls
- E. Section 232113: Hydronic Piping, Valves and Specialties
- F. Section 232123: Hydronic Pumps
- G. Section 238239: Heat Transfer
- H. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide boilers conforming to the requirements of the latest addition of the following:
 - 1. American National Standards Institute (ANSI):
 - a. B31.1 - Power Piping
 - 2. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code

- a. Section VIII D1 - Rules for Construction of Pressure Vessels including Addendums
 - b. Section VIII D2 - Rules for Construction of Pressure Vessels including Addendums
 - c. Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums
3. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
 4. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 1. The proposed substitution does not affect dimensions shown on drawings.
 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
- B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight loading, required clearances, methods of assembly of components, and location and size of each field connection.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.
- D. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.
- E. Boiler Certification: The boiler manufacturer shall submit evidence that the boiler(s) meet the requirements of the standards specified.

- F. Commissioning Test Plan: Submit test plan for boilers. Plan shall include test schedules, and names and titles of the test personnel who will be participating in the commissioning tests. The test personnel must be employees of the boiler manufacturer or the manufacturer's designated representatives. Plan shall include false loading of boilers, if the anticipated building loads at the time of test do not meet capacity requirements. Submittals shall have detailed layout for temporary equipment, if such equipment is needed, even if it is not specified or shown on the Drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum two-year warranty on boiler system and pressure vessel from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to drawings for capacities and characteristics.
- B. Manufacturers: Lochinvar #BW Series, Bryan #BE Series.

2.02 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate hot water.
- B. Pressure Vessel: Carbon-steel or cast-iron pressure vessel mounted on structural-steel base.
- C. Nozzles: Flanges or NPT threads for water inlet and outlet and heating element inserts; threaded connections for trim and controls.
- D. Insulation: Multiple layers of glass-fiber insulation. Minimum 2 inch (50 mm) thickness (total).
- E. Jacket: Galvanized sheet metal casing with baked-enamel or powder-coated protective finish and removable panels with snap-in or interlocking closures for access to pressure vessel.
- F. Lifting Lugs: Welded to pressure vessel, extending above jacket.
- G. Heating Elements: Copper or Incoloy-sheathed, replaceable electric-resistance element, rated 20-kW maximum, with maximum 75 W/sq. in. (11.5 W/sq.cm) over the heat-transfer length.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230549 "Seismic Restraint for Piping, Ductwork, and Equipment" when mounting base is anchored to building structure.
 - H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - I. ASME Compliance: Fabricate and label boilers to comply with 2021 ASME Boiler and Pressure Vessel Code.
 - J. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, Article 424.
 - K. UL Compliance: Test boilers for compliance with UL 834. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- 2.03 TRIM FOR HOT-WATER BOILERS
- A. Include devices sized to comply with ASME B31.1 or ASME B31.9.
 - B. Aquastat Controllers: Operating auto-reset high limit.
 - C. Safety Relief Valve: ASME rated and mounted vertically.
 - D. Pressure and Temperature Gage: Minimum 3-1/2-inch (89 mm) diameter, water pressure and temperature gage. Gages shall have operating pressure and operating temperature ranges, so normal operating range is about 50 percent of full range.
 - E. Boiler Air Vent: Automatic.
 - F. Dip-tube in water outlet.
 - G. Drain Valve: Minimum NPS 3/4 inch (DN 20) hose-end ball valve sized according to requirements of authorities having jurisdiction.
- 2.04 CONTROLS
- A. Refer to Section 230900 "Building Automation System (BAS) Controls" and sequence of operation.
 - B. Boiler operating controls shall include the following devices and features:
 1. Control transformer.
 2. Step controller.
 3. Recycling relay returns controller to off position after power failure.
 4. Multistage thermostat.
 5. Control-circuit switch.
 6. Visual indication for each step.
 7. Supply-voltage indicator.
 8. Set-Point Adjust: Set points shall be adjustable.

9. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain space temperature in response to thermostat with heat anticipator located in heated space.
 - a. Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.
- C. Safety Controls: To maintain safe operating conditions, safety controls limit boiler operation.
 1. High Cutoff: Automatic reset stops boiler if operating conditions rise above set point or maximum boiler design temperature and/or pressure.
 2. Low-Water Cutoff Switch: Electronic or Float and electronic probe shall prevent boiler operation on low water. Cutoff switch shall be automatic-reset type.
 3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
 4. Hardwired Points:
 - a. Monitoring: On/off status and common trouble alarm as a minimum.
 - b. Control: On/off operation and hot water supply temperature set-point adjustment as a minimum.
 5. A communication interface with building automation system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available and monitoring points displayed locally at boiler control panel shall be available through building automation system.

2.05 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.
 1. Field power interface shall be to fused disconnect switch or non-fused disconnect switch. Refer to electrical design drawings for power wiring and connection to circuit breaker.
 2. Interlock with door to de-energize power with door open.
- B. Electrical Enclosures: NEMA 250, Type 1 enclosure with hinged door and key-locking handle.
- C. Install factory wiring outside of an enclosure in a metal raceway.
- D. Comply with NFPA 70.
- E. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.
- F. Contactors: Three-pole magnetic contactors, listed for 500,000 cycles at full load.
- G. Factory-wired internal control devices and heating elements. Wiring shall be numbered and color coded to match wiring diagram.

2.06 EMERGENCY SHUTDOWN SWITCH

- A. Emergency boiler room shutdown switch for mounting outside boiler room doors. Mechanical to provide and install for complete and operational system per ASME CDS-1. Switch shall work independently of Building Automation System. Features shall include:

1. Emergency off push button. Button shall be red with white lettering. 1-1/2" diameter. Button type shall include latching action upon activation. Button type shall be "turn-to-reset" after a boiler incident has been resolved.
 2. Housing: Polycarbonate or metal for recessed wall installation. Cover shall be clear and hinged to protect button from accidental activation.
 3. Output: SPDT relay for 120-240 V AC service.
 4. Operating Temperature Range: -40°F to 250 °F.
 5. Mounting: Located switch at 48" above finished floor in compliance with ADA.
- B. Signage: Mount aluminum or plastic warning sign above switch. Sign shall be minimum 7" wide by 5" tall with red background and white lettering. Text of sign shall be "BOILER EMERGENCY SHUTOFF".
- C. Switch Manufacturers: Safety Technology International #Stopper Station Series.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
 2. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. All equipment, unless otherwise shown or noted, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Boilers are to be installed on concrete housekeeping pads. Provide manufacturer and code clearance all around and provide minimum 48" clearance between boilers.
- C. Install boiler trim not installed at factory.
- D. Connect to supply and return water piping, drain and relief piping.
- E. Relief valves are to be piped and terminated above approved termination location as required by code.
- F. Flush and clean boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.
- G. Hydrostatically test assembled boiler(s) and piping in accordance with applicable sections of ASME "Boiler and Pressure Vessel Code".

3.03 EMERGENCY BOILER SHUTDOWN

- A. All electric boilers with input greater than 117 kW shall have a manually operated remote shutdown switch to shutdown boiler(s) and associated equipment. Activation of the emergency shutdown switch shall immediately shut off the energy supply and initiate the boiler shutdown sequence in accordance with manufacturer's recommendations where applicable.
- B. The shutdown switch should be located just outside the boiler room door and marked with signage for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.
- C. Comply with local building and mechanical codes for additional requirements. Comply with ASME CDS-1 and ASME Boiler and Pressure Vessel Code (BPVC) Section HG-634.
- D. Provide conduit, wiring, relays, devices, etc., as required for complete and operational emergency shutdown system including shutdown of boiler(s) and associated pump(s) and valve(s) as necessary. Coordinate with electrical design as necessary. Shutdown system shall operate independently of BAS, but BAS should monitor activation of switch for remote indication. Coordinate with BAS contractor for interface.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 230500 "Basic HVAC Materials and Methods."
- C. Connect hot-water piping to supply and return water boiler tapplings with shutoff valve and union or flange at each connection.
- D. Install piping from safety relief valves to nearest floor drain, floor sink or other approved location.
- E. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- F. Install piping adjacent to boiler to allow service and maintenance.
- G. Ground equipment according to Section 260526 "Grounding and Bonding."
- H. Connect wiring according to Section 260519 " Low-Voltage Electrical Power Conductors and Cables."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service.
- B. Perform installation and startup checks according to manufacturer's written instructions.

- C. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- D. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Adjust initial temperature set points.
- G. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.
- I. Prepare written report that documents testing procedures and results.

3.06 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify boiler mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 52 16
CONDENSING BOILER

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 1. Commercial Firetube Condensing Hot Water Boiler
 2. Commercial Watertube Condensing Hot Water Boiler
 3. Residential Condensing Hot Water Boiler
 4. Condensate Neutralizer

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230548: Vibration Isolation for Piping, Ductwork and Equipment
- C. Section 230593: Testing, Adjusting and Balancing
- D. Section 230716: Equipment Insulation
- E. Section 230900: Building Automation System (BAS) Controls
- F. Section 232113: Hydronic Piping, Valves and Specialties
- G. Section 232123: Hydronic Pumps
- H. Section 233113: Air Distribution
- I. Section 238239: Heat Transfer
- J. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

- B. Codes and Standards: Provide boilers conforming to the requirements of the latest addition of the following:
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. All components to comply with NEMA Standards.
 2. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
 3. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
 4. CSA Compliance: Test boilers for compliance with CSA B51.
 5. American Boiler Manufacturer's Association (ABMA) "Standard Test Procedure for Packaged Firetube Boilers". Label boiler with ABMA emblem on boiler nameplate.
 6. AHRI certified efficiency shall be equal to or greater than specified efficiency. Testing shall be done to BTS2000 Standards.
 7. American National Standards Institute (ANSI):
 - a. B31.1: Power Piping.
 - b. Z21.13: Gas-Fired Low Pressure Steam and Hot Water Boilers, including addendums.
 8. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code (BPVC):
 - 1) Section IV: Rules for Construction of Heating Boilers.
 - 2) Section VIII D1: Rules for Construction of Pressure Vessels including Addendums.
 - 3) Section VIII D2: Rules for Construction of Pressure Vessels including Addendums.
 - 4) Section IX: Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums.
 9. National Fire Protection Association (NFPA):
 - a. 70: National Electrical Code.

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
1. The proposed substitution does not affect dimensions shown on drawings.
 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
- B. Seismic Qualification Certificates: For boiler, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight loading, required clearances, methods of assembly of components, and location and size of each field connection.
- D. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.
- E. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.
- F. Boiler Certification: The boiler manufacturer shall submit evidence that the boiler(s) meet the requirements of the standards specified.
- G. Vent Manifolds Coordination: For boiler plant installation requiring multiple boilers venting into a common vent stack, the vent design is to be provided by the same manufacturer's representative as the boiler manufacturer's representative. In addition, a sign-off is required from the submitted boiler manufacturer attesting to their approval of the proposed venting arrangement.
- H. Commissioning Test Plan: Submit test plan for boilers. Plan shall include test schedules, and names and titles of the test personnel who will be participating in the commissioning tests. The test personnel must be employees of the boiler manufacturer or the manufacturer's designated representatives. Plan shall include false loading of boilers, if the anticipated building loads at the time of test do not meet capacity requirements. Submittals shall have detailed layout for temporary equipment, if such equipment is needed, even if it is not specified or shown on the Drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Refer to Section 230500 for basic warranty requirements.
- B. Guarantee and warranties: The entire boiler/burner package shall be guaranteed and warranted by the boiler manufacturer.
 - 1. Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:
 - a. Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.
 - b. Thermal shock or stress, for a period of twenty (20) year, minimum, non-prorated warranty against damage.
 - 2. Warranty Period for the Burner: The boiler manufacturer shall warranty the mesh burner head against defective material or workmanship for a period of five (5) years, non-prorated, from the date of shipment from the factory.
 - 3. Warranty Period for all other components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material for a period of two (2) years, non-prorated, from the date of shipment from the factory.

PART 2 PRODUCTS

2.01 GENERAL

- A. For multiple boiler installations with boilers vented to a common vent, the boilers shall be symmetrically air-fuel coupled such that any changes in the combustion air-flow or flue flows shall affect the BTUH input without affecting the combustion quality.

2.02 COMMERCIAL FIRETUBE CONDENSING BOILER

- A. Designs not requiring a dedicated boiler pump either internally to the boiler or as a secondary system pump. The Condensing Boiler shall function properly in a Primary Pumping Variable Flow System with motorized isolation valves on individual boilers.
 - 1. Manufacturers: Fulton Endura, Aerco Benchmark, Cleaver-Brooks Clearfire, Viessmann Vitocrossal, Lochinvar Crest, Riello RTC, Raypak XVers-Type H.
- B. Designs which require a dedicated boiler pump:
 - 1. Acceptable Manufacturers: Hamilton EVO, Lochinvar Knight XL.
- C. General: Factory packaged unit shall include boiler, burner, painted insulated steel jacket, controls and accessories all piped and wired for single point field connections. Unit's burner and controls shall be in accordance with ASME/CSD-1 and all codes required by the local governing authorities and as indicated on the design criteria data sheet. Boiler's minimum overall efficiency shall be listed in mechanical schedule. ASME certified, labeled, stamped, and designed for 125 PSIG water in accordance with Section IV of ASME Code. Unit shall be designed to Seismic Zone requirements applicable to boiler location. Manufacturer's Representative to provide services for field testing and adjusting of boiler and controls to meet design requirements.

- D. Boiler Type: Stainless steel firetube boiler for positive pressurized firing. Fully condensing. Positive pressure Category IV for individually vented boiler.
- E. Minimum Construction Features:
1. Boiler shall be mounted on heavy steel base.
 2. Boiler pressure vessel to have dual return design to maximize operating efficiency.
 3. Boiler shall be provided with a drain and means to flush and clean the heat exchanger.
 4. Boiler shall be covered with a minimum of 1/2 inch of insulation under a gas tight casing.
 5. Burner shall be provide a means for readily accessible furnace access.
 6. The boiler shall permit either no minimum flow or provide control to cycle the burner off at zero flow allowing the boiler to be suitable for operation in Primary Pumping Variable Flow System.
- F. Critical Efficiency Related Performance Criteria:
1. Regardless of the venting materials specified in the construction documents, the submitted boiler shall be capable of being vented with PVC, CPVC, or Polypropylene.
 2. The boiler shall be capable of operating in a variable primary piping arrangement with turndown and controls able to meet the target loop set point.
- G. Burner:
1. General: Forced draft natural gas burner, woven fiber mesh design, with variable speed blower fan; motor; air damper; linkage; air flow switch; fuel train; and control panel. Burners and controls to conform to ASME/CSD-1 and other insurance requirements as indicated. Burner designed for sealed combustion.
 2. Gas Train: Minimum main gas train shall include manual shut-off valve, pressure regulating valve, dual gas valves, manual test valve, and high-low gas pressure switches. Gas train shall be factory packaged to meet insurance requirements as indicated.
 3. Excess Air: The burner shall be capable of operating at no greater than 8.0% excess O₂ over the entire modulation range to maximize seasonal combustion and thermal efficiencies.
 4. NO_x Emissions: When operating on natural gas, the burner shall maintain a level of <20 ppm over the complete combustion range at a 3% O₂ correction. The natural gas burner shall be configurable down to <9 ppm NO_x when operating on 460/3/60 electrical service.
- H. Boiler Plant Turndown: Effective plant capacity turndown is to be a minimum of 10:1. This may be achieved by combination of multiple boilers with boiler turndown. Minimum boiler turndown to be no less than five to one.
- I. Boiler Trim: To include the following:
1. Temperature gauge.
 2. Pressure gauge.
 3. ASME safety relief valve.
 4. Operating control.
 5. Limit control with manual reset.
 6. Low water cut-off or flow switch for boilers with low volume heat exchangers.
 7. Modulating controller.

8. Condensate neutralizer kit.
9. Drain valve.

J. Control:

1. Panel: Boiler mounted enclosure to include fusing; step-down control transformer and boiler controls.
2. Boiler controls shall feature a standard, factory installed graphic LCD screen display with navigation dial or touchscreen interface and includes the following standard features:
 - a. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - b. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 - c. Maintenance reminder: Boiler shall have the ability to display a, customizable maintenance notification screen. All notifications are adjustable by the installer based upon months of installation, hours of operation, and number of boiler cycles.
 - d. English Error codes: Boiler shall have a user interface that displays a red error screen with fault codes that are displayed in English and include a date and time stamp for ease of servicing.
 - e. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 - f. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
 - g. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature by sending the boiler a control input signal.
 - h. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, space heat run hours, domestic hot water run hours and ignition attempts. All data should be visible on the boiler screen.
3. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to eight boilers of different BTUH inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
 - a. Lead lag: The Control module shall allow only one boiler to fire at the beginning of a call for heat. Once the lead boiler is in full fire and the control calculates that additional heat is required it will call on an additional boiler as needed.
 - b. Efficiency optimization: The Control module shall allow multiple boilers to simultaneously fire at minimum firing rate in lieu of Lead/Lag.
 - c. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
 - d. For multi-boiler installations, in the event of the lead master control boiler being powered down for service or failure, the controls shall automatically shift the assignment of master controller duty to an active boiler including the reassignment of the remote header sensor

- e. Boiler on board controller shall include the following capability:
 - 1) Set-Point Adjust: Set points shall be fully adjustable by the installer.
 - 2) Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
 - 3) Sequence of Operation: Boiler shall come standard with outdoor reset control which will control burner firing rate to reset supply-water temperature inversely with outside-air temperature.
- 4. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation and include:
 - a. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
 - b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 - c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - d. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 - e. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 - f. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 - g. Optional Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
- 5. Building Automation System Interface:
 - a. Hardwired Interface: Boiler shall have the ability to receive a 0-10V or 4-20 mA signal from a building management system to control setpoint and start/stop.
 - b. Communication Interface: Factory installed Modbus gateway interface or BACnet MSTP or IP interface to enable building automation system to monitor, control, and display boiler status and alarms.
- K. Manufacturers Field Services: Provide (2) days of start-up, balancing, testing, and owner instruction. Testing shall include written reports on boiler firing rate, turndown, efficiency, motor amperage, O₂, CO, NO_x levels, flue gas temperature, ambient temperature, and all control settings.

2.03 WATER-TUBE CONDENSING BOILERS

- A. Description: Factory-fabricated, -assembled, and -tested, stainless steel, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- B. Manufacturers: Lochinvar Knight XL, Hamilton EVO, Hamilton 3VO, RBI Infinite Energy 2, Raypak X-Fyre, HTP Mod Con, Thermal Solutions Arctic, Viessmann Vitodens 200-W, Camas DynaForce .

- C. Heat Exchanger:
 - 1. 316 L Stainless steel heat exchanger
 - 2. Staged designs consisting of a non-condensing ferrous or copper tube heat exchanger in combination with a condensing stainless steel heat exchanger is prohibited by this specification.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Forced draft drawing from gas premixing valve.
- F. Blower: Variable speed centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Direct spark ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Circulator to meet or exceed the warranty of the boiler heat exchanger.
- J. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Finish: Primed and pre-painted.
 - 3. Insulation: Minimum ½ -inch- (12.5-mm-) mineral-fiber insulation surrounding the heat exchanger.
 - 4. Combustion-Air Connections: Inlet and vent duct collars.
- K. Boiler Plant Turndown: Effective plant capacity turndown is to be a minimum of 10:1. This may be achieved by combination of multiple boilers with boiler turndown. Minimum boiler turndown to be no less than five to one.
- L. Boiler Trim with following features:
 - 1. Combination temperature/pressure gauge
 - 2. ASME safety relief valve
 - 3. Operating control
 - 4. Limit control with manual reset
 - 5. Low water cut-off or flow switch cut-off
 - 6. Modulating controller
 - 7. Condensate neutralizer kit
 - 8. Drain valve
- M. Control:

1. Panel: Boiler mounted enclosure to include fusing; step-down control transformer and boiler controls.
2. Boiler controls shall feature a standard, factory installed graphic LCD screen display with navigation controls. The controls are to include the following standard features:
 - a. Boiler Pump Control: Provide control of the dedicated boiler pump for either variable speed control or constant speed control as required by the manufacturer to maintain a designed temperature rise across the heat exchanger with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F. Project specific temperature rise shall be ____ at full fire.
 - b. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - c. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 - d. Error codes: Boiler shall have a user interface that displays an error screen with fault codes for ease of servicing.
 - e. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 - f. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature by sending the boiler a 0-10V input signal.
3. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
 - a. Lead lag: The Control module shall allow only one boiler to fire at the beginning of a call for heat. Once the lead boiler is in full fire and the control calculates that additional heat is required it will call on an additional boiler as needed.
 - b. Efficiency optimization: The Control module shall allow multiple boilers to simultaneously fire at minimum firing rate in lieu of Lead/Lag.
 - c. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
 - d. Boiler on board controller shall include the following capability:
 - 1) Set-Point Adjust: Set points shall be fully adjustable by the installer.
 - 2) Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
 - 3) Sequence of Operation: Boiler shall come standard with outdoor reset control which will control burner firing rate to reset supply-water temperature inversely with outside-air temperature.
4. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation and include:
 - a. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.

- b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 - c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - d. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 - e. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 - f. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 - g. Optional Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.
5. Building Automation System Interface:
- a. Hardwired Interface: Boiler shall have the ability to receive a 0-10V system from a building management system and control by the following:
 - 1) 0-10V DC input to control Setpoint
 - 2) 0-10V DC input Enable/Disable signal
 - b. Communication Interface: Factory installed Modbus gateway interface or BACnet IP interface to enable building automation system to monitor, control, and display boiler status and alarms.
- N. Manufacturers Field Services: Provide (2) days of start-up, balancing, testing, and owner instruction. Testing shall include written reports on boiler firing rate, turndown, efficiency, motor amperage, O₂, CO, NO_x levels, flue gas temperature, ambient temperature, and all control settings.

2.04 SMALL/RESIDENTIAL CONDENSING BOILER

- A. General: Factory packaged high efficiency condensing unit shall include boiler, burner, painted jacket, controls and accessories all piped and wired for single point field connections.
- 1. The boiler shall be high efficiency condensing units that meet or exceed an efficiency of 92% tested and certified to AFUE standards, and exceed ASHRAE/103-93 minimum efficiency requirements. The boiler shall be Energy Star approved. The boiler shall be constructed in accordance with ANSI Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers, ANSI Z21.13b-1994, Canadian National Standard CGA-4.9-1999.26UB, UL/ULC (File #MH27745). Listed and be in accordance with all codes and authorities having jurisdiction. The boiler shall bear the ASME "H" Stamp for working pressure of 125 psi and shall be national board listed.
 - 2. The boiler heat exchanger and combustion shell shall be constructed entirely of 316-L or 439 stainless steel. The combustion shell shall be designed to collect condensation allowing it to be discharged by gravity to an approved plumbing discharge location. The heat exchanger tubes shall be water tight with high temperature o-rings to the header, which are held in place with stainless steel banding.

3. The boiler shall be a sealed combustion system of natural or liquid propane gas-fueled with a modulating power burner and positive pressure discharge. The intake/exhaust shall be piped with a Minimum diameter Plastic PVC or ABS schedule 40, 80 solid, Non Foam Core of a diameter specified by the manufacturer. Boiler shall be approved for both direct-horizontal venting as well as vertical venting. The exhaust shall maintain a minimum of 1/4" per foot slope toward boiler to control condensate and rainwater. All related intake/exhaust piping shall be approved for zero clearance to any combustible surface. Boiler shall operate at combustion efficiency no less than 92%. The combustion block shall be insulated and secured in a durable non-ferrous enclosure. All components shall be located in the front of the heater for access of serviceability.
4. The operation of the boiler shall be in a closed-loop-pressurized system, which shall have properly sized thermal expansion tank(s), or meet local codes. Boiler shall be supplied with an ASME rated 30 PSI relief valve and equipped with a water pressure switch to monitor system pressure.
5. The boiler shall have a load matching modulating range of a minimum 3.7:1 ratio to BTU/hr output. To prevent short cycling, the boiler shall step fire on start-up before engaging full modulation.
6. The blower motor shall have permanently lubricated sealed ball bearings, with inherent overload protection. Motors shall be mounted inside the unit casing.
7. Manufacturer: Hamilton EVO, Lochinvar Cadet, Lochinvar Knight, HTP Elite, Burnham Alpine, Lennox GWM-IE, Viessmann Vitodens 200-W B2HB, Aerco EST 399.

B. Connections:

1. Gas supply: Shall be a minimum size of 3/4" inside diameter for boilers less than 200,000 BTU's, and 1 1/4" gas connections for boilers of 399,000 with CSD-1 gas train. Check sizing charts if larger sizes are required due to long distances and other gas competing appliances.
2. Supply and Return Water: The boiler shall have a minimum 1 1/4" Supply and Return water connections for boilers less than 200,000 BTU's, and 2" connections for boilers of 399,000 BTU's.
3. Condensate water: Shall be directed to an approved plumbing termination location or to the exterior of the building via minimum 3/4" copper Type L tubing at a 1/4" per foot slope away from the boiler (larger diameter pipe may be necessary for longer lengths). If condensate is directed to a drain, a condensate neutralizer must be utilized or sanitary sewer shall connect downstream of readily used fixture and waste pipe shall be acid resistant. If proper boiler condensate grade is not obtainable, a condensate pump must be installed to elevate condensate to termination location.

C. Controls

1. The heating unit shall include integral operating controls to govern all operations and energy input. Controls shall be integrated solid-state temperature and spark ignition control with integral diagnostics. A service disconnect switch shall be factory installed on the exterior of the boiler. Boiler shall include factory installed control sensors on the boiler water connections inlet and outlet.
2. The boiler shall provide integral outdoor reset control. The control shall have a differential switch with setting 6-12-20-30 differential range with an operating range of 70° F -190° F with a resettable high limit switch. The control shall utilize an algorithm to fully adjust the firing rate while maintaining the desired output temperature.
3. Controller shall include self-diagnostic controls which monitor all interlocks and provide fault information with an easy computer interconnection port for clear data viewing and downloading to a PC.

4. Controller shall consist of a main circuit board with power supply transformer and provide the following functions on the main circuit board:
 - a. Power supply unit for voltage supply of controller.
 - b. Micro controller for controlling and monitoring the boiler unit.
 - c. Various analog sensor connections (temperature sensors).
 - d. LCD and LEDs for displaying data and operating conditions of the controller.
 - e. Pushbuttons for operating the controller.
 - f. Various plug connections.
5. Boiler shall include the following boiler control safeties, integral to control board:
 - a. Safety Limit high limit switch w/manual reset, factory set at 225°F.
 - b. Safety Limit Flue w/manual reset, factory set at 210°F.
 - c. High Limit w/manual reset on outlet pipe, factory set at 230°F.
 - d. Flame Failure Lockout after three tries. Retry ignition sequence every hour.
 - e. Combustion air/exhaust proving switch w/Manual reset.
 - f. Gas Valve continuity check w/Manual reset.
 - g. Flame sensor detector fault w/Manual reset.
 - h. Supply sensor continuity check w/Manual reset.
 - i. Fan Speed parameter check w/Manual reset.
6. The following are required accessories provided with the boiler as part of the bid package. These accessories shall include all components necessary to install and operate the boiler and comply with state codes.
 - a. Low Water Cut Off w/manual reset.
 - b. Concentric flue.
 - c. ASME Boiler safety relief valve.
 - d. Flue gas condensate neutralizing kit.
7. The following are typical accessories that shall be provided in the system construction to provide a complete and operational system and as specified in the construction documents.
 - a. Circulating pump, flanged, with a flow rate & foot of head sized to boiler and system.
 - b. Shut off valves and flange set.
 - c. Y-strainer.
 - d. Zone circulator control.
 - e. Pressure gauges on inlet and outlet.
 - f. Thermometer on inlet and outlet.
 - g. Air separator.
 - h. Hydronic expansion tank.
 - i. Pressure reducing valve adjustable from 10-25 psi.
 - j. Back flow preventer.

8. Electrical System

- a. The electrical system shall conform to National Electrical Code requirements. The control circuit shall be 24 volts AC, wire in accordance with NEC Class II requirements. The control circuit wire shall not be smaller than 18 AWG. Each wire shall end with a service loop and be securely fastened by an approved method. Each wire in the unit shall be numbered for ease of service tracing. All electrically actuated components shall be easily accessible from the front of the unit without reaching over exposed high voltage components or rotating parts. The blower motor shall have thermal and short circuit protection. Line voltage and 24 volt control circuit wiring shall be routed in separate bundles.
- b. All wiring and transformers shall be provided by this Division unless otherwise indicated in construction documents. Coordinate with electrical contractor for line voltage power.

2.05 CONDENSATE WATER NEUTRALIZER

- A. Provide PH Neutralizer for condensate neutralization on all condensing boilers.
- B. Manufacturer: J.M. Boiler Works, Axiom Neutra Series PH neutralizer.

2.06 EMERGENCY SHUTDOWN SWITCH

- A. Emergency boiler room shutdown switch for mounting outside boiler room doors. Mechanical to provide and install for complete and operational system per ASME CDS-1. Switch shall work independently of Building Automation System. Features shall include:
 1. Emergency off push button. Button shall be red with white lettering. 1-1/2" diameter. Button type shall include latching action upon activation. Button type shall be "turn-to-reset" after a boiler incident has been resolved.
 2. Housing: Polycarbonate or metal for recessed wall installation. Cover shall be clear and hinged to protect button from accidental activation.
 3. Output: SPDT relay for 120-240 V AC service.
 4. Operating Temperature Range: -40°F to 250 °F.
 5. Mounting: Located switch at 48" above finished floor in compliance with ADA.
- B. Signage: Mount aluminum or plastic warning sign above switch. Sign shall be minimum 7" wide by 5" tall with red background and white lettering. Text of sign shall be "BOILER EMERGENCY SHUTOFF".
- C. Switch Manufacturers: Safety Technology International #Stopper Station Series.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

2. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. All equipment, unless otherwise shown or noted, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Boilers are to be installed on concrete housekeeping pads or concrete inertia base. Provide manufacturer and code clearance all around and provide minimum 48" clearance between boilers. Provide neoprene isolation pads or vibration isolators as required by manufacturer or as shown on drawings.
- C. Install boiler trim not installed at factory.
- D. Connect to supply and return water piping, natural gas/fuel piping, flue vent, combustion air duct and relief piping.
- E. Relief valves are to be piped and terminated 1" above approved termination location.
- F. Flush and clean boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls
- G. Hydrostatically test assembled boiler(s) and piping in accordance with applicable sections of ASME "Boiler and Pressure Vessel Code".
- H. Arrange for inspection of boiler and piping, observation of hydrostatic testing, and for certification of completed boiler units by an authorized inspector in accordance with NBBPVI NB23. Provide all scaffolding, ladders, opening of vessels, filling, draining, lights, closing of vessels and services to support the authorized inspector.
- I. Install boiler manufacturer provided condensate "air-traps" where provided with condensing boilers. Install traps per manufacturer's instructions and install condensate piping as required by local code.
- J. PH Neutralizers are to be piped with PVC tubing. All piping to be per manufacturer's diagrams and instructions. Neutralizer tube to be secured to floor or wall out of normal walking path. The tubes and p-traps are to be filled with water before firing any boiler. Neutralizer tube to be charged prior to installation and a minimum of material for one recharge to be supplied.

3.03 EMERGENCY BOILER SHUTDOWN

- A. All automatically fired boilers with input greater than 400,000 Btuh shall have a manually operated remote shutdown switch to shutdown boiler(s) and associated equipment. Activation of the emergency shutdown switch shall immediately shut off the fuel or energy supply and initiate the boiler shutdown sequence in accordance with manufacturer's recommendations where applicable.
- B. The shutdown switch should be located just outside the boiler room door and marked with signage for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.

- C. Comply with local building and mechanical codes for additional requirements. Comply with ASME CDS-1 and ASME Boiler and Pressure Vessel Code (BPVC) Section HG-634.
- D. Provide conduit, wiring, relays, devices, etc., as required for complete and operational emergency shutdown system including shutdown of boiler(s) and associated pump(s) and valve(s) as necessary. Coordinate with electrical design as necessary. Shutdown system shall operate independently of BAS, but BAS should monitor activation of switch for remote indication. Coordinate with BAS contractor for interface.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 230500 "Basic HVAC Materials and Methods."
- C. Connect gas piping full size to boiler gas-train inlet with union.
- D. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- E. Install piping from safety relief valves to nearest floor drain, floor sink or other approved location.
- F. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- G. Connect breeching full size to boiler outlet.
- H. Install piping adjacent to boiler to allow service and maintenance.
- I. Ground equipment according to Section 260526 "Grounding and Bonding."
- J. Connect wiring according to Section 260519 " Low-Voltage Electrical Power Conductors and Cables."
- K. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service.
- B. Perform installation and startup checks according to manufacturer's written instructions.
- C. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- D. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- F. Adjust initial temperature set points.
- G. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.
- I. Verify onboard master control is automatically shifted to available functioning boilers in multiple boiler installations. Cycle through boiler bank to ensure that all boilers shift and accept the master controller duty.
- J. Prepare written report that documents testing procedures and results.

3.06 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify boiler mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 52 19

AIR TO WATER HEAT PUMP

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Packaged, air-cooled, electric-motor-driven, scroll compressors, water Heat Pump.

1.02 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

PART 2 PRODUCTS

2.01 PACKAGED AIR TO WATER HEAT PUMP

- A. Description: Factory-assembled and performance-tested water heat pump complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- B. Cabinet:
 - 1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
 - 2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
 - 3. Casing: Galvanized steel.
 - 4. Finish: Coat base, frame, and casing with rustproof polyester paint.
- C. Compressors:
 - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
 - 2. Each compressor provided with crankcase oil heater, and suction strainer.
 - 3. Capacity Control: On-off compressor cycling.
 - 4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
 - 5. Vibration Isolation: Mount individual compressors on vibration isolators.
 - 6. Compressors must be enclosed in acoustically insulated and weatherproof compartment.
- D. Refrigeration:
 - 1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, a reverse cycle valve, a liquid separator, a liquid accumulator, a filter-dryer, a sight glass with moisture indicator, a liquid accumulator, a liquid-line solenoid valve, and an insulated suction line.
 4. Each unit shall have two refrigeration circuits.
- E. Evaporator:
1. Brazed Plate:
 - a. Direct-expansion, single-pass, brazed-plate design.
 - b. Type 316 stainless-steel construction.
 - c. Heat exchanger shall have two independent refrigerant circuits, one water circuit
 2. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator.
 3. Evaporator shall be provided with a factory installed inlet strainer.
- F. Air-Cooled Condenser:
- 1.
 2. Condenser shall be constructed of copper pipes and aluminum fins.
 3. Condenser shall use V-block configuration.
 4. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
 5. Fan Motors: Inverter driven totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
 6. Fan Guards: Steel safety guards with corrosion-resistant coating.
 7. Unit shall be able to modulate the fan speed based on high pressure when in cooling mode, and based on low pressure when in heating mode.
- G. Controls:
- 1.
 2. Unit shall be equipped with a standalone microprocessor based control system. The control logic shall be designed to maximize operating efficiency and equipment life with protections for operation under unusual conditions. The system shall intelligently stage the unit to sustain leaving water temperature precision and stability while minimizing compressor cycling.
 3. The controller shall support the following safety and operating controls: high pressure switches for each refrigerant circuit; loss of flow in the evaporator water circuit; condenser fan staging by head pressure; digital setting of low evaporator water temperature cutout, high pressure cutout, suction pressure cutout, and freeze protection cutout; compressor soft loading; demand limit control based on 4-20 mA DC signal input; automatic circuit lead/lag based on fewest operating hours (with manual override); chilled water reset based on an externally applied 4-20 mA signal.
 4. The keypad/display shall provide access to all vital equipment data. Data shall include full description of current unit status, set point parameters, and alarms.

5. Control system shall: continuously perform self-diagnostic checks; monitor all system temperatures, pressures and safeties; and shall automatically shut down a compressor, refrigerant circuit or entire unit should a fault occur. Diagnostic function shall provide operator with a pre-alarm status indication allowing time to take corrective action prior to a safety shutdown.
6. Controller shall provide output contact closure for control of chilled water pump
7. The chiller shall be capable of communications with any Building Automation System supporting BACnet, Modbus and LONworks communications protocol. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.

H. Defrost

1. The units must include intelligent defrost. This allows the unit to go in defrost only when is needed, avoiding unnecessary defrost cycles. This shall be achieved by monitoring the suction pressure decay and the OAT.
2. The unit must have the ability to defrost one circuit at the time.
3. Timed defrost is not allowed.
4. Heat pumps performance and efficiency should take into consideration of defrost cycles.
5. Defrost cycle should not usually be less than 2 minutes and not more than 6 minutes.
6. During defrost cycle, condenser fan should be off.
7. Defrost will start only when external air temperature is less than 50F .
8. Low pressure threshold on the coil should be less than 5.2 bar/75.42 Psi.
9. When the pressure variations between clean and uncleaned coil is 0.6 bar/8.70 psi, defrost will start automatically.
10. Minimum time between two defrost should be greater than 15 minutes

2.02 SOURCE QUALITY CONTROL

- A. Heat pump shall be manufactured in an ISO 9001 certified facility.
- B. Each unit shall be factory performance tested on a third party certified test stand to ensure proper operation, full load efficiency and full load capacity. Test reports shall be made available to owner and engineer upon request.
 1. Functional Test
 - a. Pre-charge unit with nitrogen and test for leakage
 - b. Establish a vacuum to remove all gas and to eliminate moisture inside the refrigerant circuit
 - c. Charge the unit with refrigerant
 - d. Connect the evaporator and condensers inlet and outlet water connections to the testing room plant
 - e. Set the water flow to the design flow rate
 - f. Connect power to the unit and carry out test of voltage and frequency on the electrical panel
 - g. Program the microprocessor control with basic working parameters

- h. Set up the valves and trim the refrigerant charge
 - i. Start up each compressor and test electrical data
 - j. Set up all the pressure switches
 - k. Calibrate the various temperature and pressure probes on the circuit
2. Performance Test
- a. Test the following alarms on the microprocessor through run test
 - 1) High pressure alarm
 - 2) Low pressure alarm
 - 3) Compressors alarm
 - 4) Evaporator freeze alarm
 - b. Test probe failures
 - c. Run the chiller in the production climatic test chamber at full load conditions
 - d. Record the performance data on the test report sheet and provide a copy to engineer and owner.
3. Sound Compliance: Chiller sound power levels shall be rated according to ISO 9614-2 and sound pressure levels rated to ISO 3744 standards. If alterations are made to a standard chiller to comply with the sound requirements, the manufacturer must provide a sound performance test in a certified facility. It shall provide overall "A" weighted sound pressure levels based on measurement taken 30 feet from the side of the heat pump.
4. Products shall be designed, tested, rated and certified in accordance with, and installed in compliance with applicable sections of the following standards and codes:
- a. AHRI 550/590 and 551/591-water chilling packages using the vapor compression cycle
 - b. AHRI 370-sound rating of large outdoor refrigerating and air-conditioning equipment
 - c. ANSI/ASHRAE 34-Number designation and safety classification of refrigerants
 - d. ASHRAE 90.2-Energy Standard of Building except Low-rise Residential Buildings
 - e. ANSI/NFPA 70-National Electrical Code(N.E.C)
 - f. Confirm to Intertek Testing Services for construction of chiller and provide ETL listed Mark.
 - g. The unit should have IP24 protection level for outdoor installation.
5. There should be arrangements for standard factory performance witness test on In-house AHRI certified test chambers. Custom factory test should be arranged to see the performance of the unit at any given operating conditions within limits of operating envelope for the specified unit's size.
- 2.03 APPROVED MANUFACTURERS AND MODELS
- A. AERMEC shall be the base of the Design (BOD) using NRB Heat pump.
 - B. Multistack
 - C. York

D. Trane

2.04 DELIVERY, STORAGE AND HANDLING

- A. All outdoor units, indoor units, controls and piping components shall be stored and handled according to the manufacturer's recommendation.
- B. All outdoor units, indoor units, refrigerant branch units, controls and piping components shall be stored and handled according to the manufacturer's recommendation.

2.05 WARRANTY

- A. Each unit's parts are warranted to be free from manufacturing defects for up to 1 year from the date of installation.
- B. Each Unit's compressor is warranted for 1 year from the date of start up. Start up must be done within 90 days of installation. Otherwise the warranty will start from the date of installation.
- C. Valves, storage tank, expansion tank and control are warranted to be free from defects for up to 1 year from the date of installation.
- D. Complete Air to Water Heat Pump Warranty including labor (3-yr part & labor)

END OF SECTION

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SECTION 23 57 00
HEAT EXCHANGERS FOR HVAC

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Shell and tube heat exchangers.
 - 2. Gasketed plate and frame type heat exchangers.
 - 3. Brazed plate and frame heat exchangers.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230548: Vibration Isolation for Piping, Ductwork and Equipment
- C. Section 230549: Seismic Restraint for Piping, Ductwork and Equipment.
- D. Section 230593: Testing, Adjusting and Balancing
- E. Section 230716: Equipment Insulation
- F. Section 230900: Building Automation System (BAS) Controls
- G. Section 232113: Hydronic Piping, Valves and Specialties
- H. Section 232123: Hydronic Pumps
- I. Section 232213: Steam and Condensate Piping, Valves and Specialties
- J. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

- B. Codes and Standards: Provide components and pumps conforming to the requirements of the latest addition of the following:
 - 1. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code
 - a. Section VIII D1 -Rules for Construction of Pressure Vessels including Addendums
 - b. Section VIII D2 - Rules for Construction of Pressure Vessels including Addendums
 - c. Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums
 - d. B31.1 - Power Piping

1.05 SOURCE QUALITY CONTROL

- A. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
- B. Heat exchangers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, gasket material, finishes of materials, and installation instructions.
- B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.
- C. Maintenance Data: Submit operation and maintenance instructions, including instructions for lubrication, tube replacement, gasket replacement schedule, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 SHELL-AND-TUBE HEAT EXCHANGERS

- A. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.
- B. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1 when system pressures exceed 15 psig (1.0 bar).
- C. Configuration: Refer to schedule on Drawings with U-tube with removable, straight tube with removable, or straight tube with fixed bundle.
- D. Shell Materials: Steel or stainless steel.
- E. Head:
 - 1. Materials: Cast iron, cast stainless steel, fabricated steel, fabricated steel with removable cover, fabricated stainless steel or fabricated stainless steel with removable cover.
 - 2. Flanged and bolted to shell.
- F. Tube: Seamless copper, cupronickel or stainless steel tubes.
 - 1. Tube diameter is determined by manufacturer based on service.
- G. Tubesheet Materials: Steel or stainless steel.
- H. Baffles: Steel or stainless steel.
- I. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
 - 1. NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2. NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- J. Support Saddles:
 - 1. Fabricated of material similar to shell.
 - 2. Fabricate foot mount with provision for anchoring to support.
- K. Capacities and Characteristics: Refer to schedule on Drawings.
- L. Manufacturer: Bell and Gossett #SU or WU Series, Alfa Laval.

2.02 GASKETED-PLATE HEAT EXCHANGERS

- A. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.
- B. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1 when system pressures exceed 15 psig (1.0 bar).
- C. Frame:

1. Capacity to accommodate 20 percent additional plates in future.
 2. Painted carbon steel with provisions for anchoring to support.
- D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
1. Fabricate attachment of heat-exchanger support bars and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger support bars and guide bars are anchored to building structure.
- E. End-Plate Material: Painted carbon steel.
- F. Tie Rods and Nuts: Steel or stainless steel.
- G. Plate Material: Refer to schedule on Drawings. 0.024 inch (0.6 mm) thick, minimum, thick before stamping. Stainless steel Type 304, 316, Alloy C276, Alloy 254 SMO or Titanium as scheduled.
- H. Gasket Materials: EPDM rubber, or better. Include maintenance schedule for replacement of gaskets based on application.
- I. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
 2. NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- J. Enclose plates in solid aluminum or stainless steel removable shroud.
- K. Capacities and Characteristics: Refer to schedule on Drawings.
- L. Manufacturer: Alfa Laval #AQ10 Series, Bell & Gossett #GPX Series.

2.03 BRAZED-PLATE HEAT EXCHANGERS

- A. Configuration: Brazed assembly, consisting of embossed or pressed stainless steel plates brazed together and two end plates, one with threaded nozzles and one with pattern-embossed plates. Floor-mounted heat exchangers must have factory-furnished integral legs with mounting feet.
- B. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1 when system pressures exceed 15 psig (1.03 bar).
- C. End-Plate Material: Type 316 stainless steel.
- D. Threaded Nozzles: Type 316 stainless steel.
- E. Plate Material: Type 316 stainless steel.
- F. Brazing Material: Copper or nickel.
- G. Capacities and Characteristics: Refer to schedule on Drawings.

- H. Manufacturer: Alfa Laval #CB Series, Bell & Gossett #BPX Series.

2.04 ACCESSORIES

- A. Hangers and Supports:
 - 1. Factory or custom-built steel supports and saddles for mounting where located on drawings.
 - 2. Supports and saddles to ensure both horizontal and vertical support of heat exchanger.
- B. Shroud for gasketed plate heat exchanger: Provide steel, stainless steel or aluminum sheet shroud.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
- B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF HEAT EXCHANGER, GENERAL

- A. Equipment Mounting:
 - 1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for equipment bases and foundations specified in Division 3 work.
 - 2. Comply with requirements for vibration isolation and seismic control devices.

3.03 INSTALLATION OF SHELL-AND-TUBE HEAT EXCHANGER

- A. Install heat exchangers on saddle supports.
- B. Heat-Exchanger Supports: Mount heat exchanger on steel saddles and supports specifically designed for each heat exchanger.
- C. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.

3.04 INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER

- A. Install wall-mounted gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

- B. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base and fasten legs to base as indicated on Drawings.
- C. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufacturer's written instructions.

3.05 INSTALLATION OF BRAZED-PLATE HEAT EXCHANGER

- A. Install wall-mounted brazed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.
- B. Install floor-mounted brazed-plate heat exchangers on cast-in-place concrete equipment base and fasten legs to base as indicated on Drawings.

3.06 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 232113 Hydronic Piping, Valves and Specialties and Section 232213 Steam and Condensate Piping and Specialties. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for piping specified in Section 232213 Steam and Condensate Piping and Specialties. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
- D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
- E. Install shutoff valves at heat-exchanger inlet and outlet connections.
- F. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.
- G. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.
- H. Pipe pressure-relief valves, full size of valve connection, to floor drain.
- I. Install vacuum breaker at heat-exchanger steam inlet connection.
- J. Install hose end valve to drain shell.
- K. Install thermometer on each heat-exchanger fluid inlet and outlet piping.
- L. Install pressure gauges on each heat-exchanger fluid inlet and outlet piping.
- M. Insulate entire shell of heat exchanger, fittings, and appurtenances so that no surfaces are exposed as required to meet energy code requirements and maximize energy efficiency.

3.07 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

- B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.
- C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

3.08 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four-hours travel from the job site.

END OF SECTION

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SECTION 23 64 00
AIR COOLED CHILLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- A. Section Includes:
 - 1. Packaged air-cooled chillers.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230716: Equipment Insulation
- D. Section 230900: Building Automation System (BAS) Controls
- E. Section 232113: Hydronic Piping, Valves and Specialties
- F. Section 232123: Hydronic Pumps
- G. Section 233113: Air Distribution
- H. Division 26: Electrical

1.04 DEFINITIONS

- A. BAS: Building Automation System.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 506/110 and referenced to AHRI standard rating conditions.

- E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
- F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 506/110 and intended for operating conditions other than AHRI standard rating conditions.

1.05 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- C. Performance Tolerance: Comply with the following in lieu of AHRI 506/110:
 - 1. Allowable Capacity Tolerance: 5 percent.
 - 2. Allowable IPLV/NPLV Performance Tolerance: 5 percent.
- D. Acoustics: Sound pressure levels for the complete unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to AHRI Standard 575-87. Data shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.
 - 1. Sound Pressure levels by octave band:

Octave Band	63	125	250	500	1000	2000	4000	8000	dB
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1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide systems conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA):
 - a. 99: Standards Handbook
 - b. 210: Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
 - c. 300: Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
 - d. 301: Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - e. 500: Test Method for Louvers, Dampers, and Shutters
 - 2. American Society for Testing and Materials (ASTM):

- a. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - b. A123: Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - c. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - d. D1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
3. American National Standards Institute (ANSI):
 - a. 9: Load Ratings and Fatigue Life for Ball Bearings
 - b. 11: Load Ratings and Fatigue Life for Roller Bearings
 - c. 207: Refrigerant-Containing Components and Accessories, Non-electrical
 - d. 303: Refrigeration and Air Conditioning Condensing and Compressor Units
 - e. 465: Central Cooling Air Conditioners
 - f. 900: Test Performance of Air Filter Units
 4. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 210: Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
 - b. 270: Sound Performance Rating of Outdoor Unitary Equipment
 - c. 550/590: Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages using the Vapor Compression Cycle.
 - 1) Submit certified data for performance at 25, 50, 75 and 100 percent of full load capacity.
 5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15: Safety Code for Mechanical Refrigeration.
 6. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code:
 - a. Section VIII D1: Rules for Construction of Pressure Vessels including Addendums.
 - b. Section VIII D2: Rules for Construction of Pressure Vessels including Addendums.
 - c. Section IX: Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums.
 7. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 8. National Fire Protection Association (NFPA): Provide unit insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70: National Electrical Code.
 - b. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
 - c. 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 9. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

10. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL. Chiller(s) shall be constructed in accordance with UL 465 "UL Standard for Safety Central Cooling Air Conditioners". Listing by Electrical Testing Laboratories (ETL) with an ETL label may also be acceptable.

1.07 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 1. The proposed substitution does not affect dimensions shown on drawings.
 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.08 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 1. Performance at AHRI standard conditions and at conditions indicated.
 2. Performance at AHRI standard unloading conditions.
 3. Minimum evaporator flow rate.
 4. Refrigerant capacity of chiller.
 5. Oil capacity of chiller.
 6. Fluid capacity of evaporator.
 7. Characteristics of safety relief valves.
 8. Fluid capacity of condenser and heat-reclaim condenser.
 9. Minimum entering condenser-fluid temperature.
 10. Performance at varying capacities with constant-design entering condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 F.
 11. Minimum entering condenser-air temperature.
 12. Maximum entering condenser-air temperature.
 13. Performance at varying capacities with constant-design entering condenser-air temperature. Repeat performance at varying capacities for different entering condenser-air temperatures from design to minimum in 10 F.
- B. LEED Submittals:

1. Product Data for Credit EA4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.09 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Startup service reports.

F. Warranty: Sample of special warranty.

1.10 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.11 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 550 and AHRI 590 certification program(s).

B. AHRI Rating: Rate chiller performance according to requirements in AHRI 506/110.

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- E. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
- F. Comply with NFPA 70.
- G. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Ship chillers from the factory fully charged with refrigerant.
- B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
- C. Ship each oil-lubricated chiller with a full charge of oil.
- D. Package chiller for export shipping in totally enclosed crate and bagging.

1.13 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.14 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within two (2) year warranty period.
 - 1. Complete chiller including refrigerant and oil charge.
 - 2. Complete compressor and drive assembly including refrigerant and oil charge.
 - 3. Refrigerant and oil charge.
 - 4. Loss of refrigerant charge for any reason.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- B. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work. This includes but is not limited to the following:
 1. Carrier Corporation.
 2. Daikin
 3. Trane.
 4. York International Corporation.

2.02 ACOUSTICS

- A. Manufacturer must provide both sound power and sound pressure data in decibels. Sound pressure data per ARI 370 must be provided in 8 octave band format at full load. In addition, A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope. Sound power must be provided in 1/3 octave band format to highlight any tonal quality issues. If manufacturer cannot meet the noise levels (per the attached chart), sound attenuation devices and / or barrier walls must be installed to meet this performance level
- B. Sound Pressure at 30 feet

Sound Pressure at 30 feet											
63 Hz	125 Hz	250 Hz	500 Hz	1 k Hz	2K Hz	4K Hz	8K Hz	Overall dBA	75% load	50% Load dBA	25% Load dBA

Sound Power											
63 Hz	125 Hz	250 Hz	500 Hz	1 k Hz	2K Hz	4K Hz	8K Hz	Overall dBA	75% load	50% Load dBA	25% Load dBA

- C. [OPTIONAL] Each compressor on two-compressor units shall have a factory-installed, rigid, sound enclosure with removable panels for compressor access.

2.03 CABINET:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.
5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:
 6. Acoustic enclosure around compressors.
 7. Reduced-speed fans with acoustic treatment.
8. Security Package: Provide removable grilles or louvered panels with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

2.04 REFRIGERATION

A. Refrigerant:

1. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
2. Refrigerant by compressor type:
- 3.

Compressor	Acceptable Refrigerant
Screw	R-134
Scroll	R-410a

2.05 COMPRESSORS

A. Scroll Compressors:

1. Compressors:
 - a. Description: Positive-displacement direct drive with hermetically sealed casing.
 - b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
2. Retain option in first subparagraph below if capacity control below the smallest chiller step is required. See Evaluations.
3. Capacity Control: On-off compressor cycling[, plus hot-gas bypass].
4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
5. Retain subparagraph below for factory-installed vibration isolation. McQuay and York are the only listed manufacturers offering these isolators.
6. Vibration Isolation: Mount individual compressors on vibration isolators.
7. Compressor Motors:

- a. Hermetically sealed and cooled by refrigerant suction gas.
 - b. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
8. Compressor Motor Controllers:
- a. Across the Line: NEMA ICS 2, Class A, full voltage, non-reversing.
- B. Screw Compressors:
1. Description: Positive displacement, hermetic or semi-hermetic compressor.
 2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
 3. Rotors: Manufacturer's standard one- or two-rotor design.
 4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.
 5. Service: Easily accessible for inspection and service.
 6. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.
 - a. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - b. Standard operating range varies among manufacturers. Not all listed manufacturers comply with options in first subparagraph below without hot-gas bypass. Consult manufacturer for requirements.
 - c. Operating Range: From 100 to 20 percent of design capacity.
 7. Condenser-Air Unloading Requirements over Operating Range: [Constant-design entering condenser-air temperature] [Drop-in entering condenser-air temperature of 5 deg F (3 deg C) drop for each 10 percent in capacity reduction] <Insert conditions>.
 8. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.
 9. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
 10. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
 - a. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
 - b. Factory-installed and pressure-tested piping with isolation valves and accessories.
 - c. Oil compatible with refrigerant and chiller components.
 - d. Positive visual indication of oil level.
 11. Vibration Control:
 - a. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.
 - b. Overspeed Test: 25 percent above design operating speed.
 12. Retain subparagraph below for factory-installed vibration isolation.
 13. Isolation: Mount individual compressors on vibration isolators.
 14. Compressor Motors:

- a. Hermetically sealed and cooled by refrigerant suction gas.
 - b. High-torque, induction type with inherent thermal-overload protection on each phase.
15. Compressor Motor Controllers:
- a. Across the Line: NEMA ICS2, Class A, full voltage, non-reversing, or solid state.
 - b. Star-Delta, Reduced-Voltage Controller: NEMA ICS2, closed transition, or solid state.
 - c. Variable Frequency Controller:
 - 1) Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
 - 2) Description: NEMA ICS2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
 - 3) Enclosure: Unit mounted, NEMA 250, with hinged full-front access door with lock and key.
 - 4) Integral Disconnecting Means: Door-interlocked, NEMA AB1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
 - 5) Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
 - 6) Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.
- C. Magnetic Levitated Centrifugal Compressor
1. Chiller to have one MagLev™, magnetic bearing, oil-free, two-stage, hermetical centrifugal compressor. Compressor to contain integrated variable speed drive with soft start and movable inlet guide vane assembly.
 2. Compressor to be microprocessor controlled. Compressor to be networked to master controller via Etherbus connection with a refresh rate of 50 microseconds and the micro processor of the compressor to control the variable speed drive and inlet guide vanes on the compressor to maximize unit efficiency.
 3. The compressor shall be capable of coming to a controlled safe stop in the event of a power outage. Unit shall be capable of auto restart in the event of a power outage, once power has been restored.
 4. The compressor is required to be mechanically and electrically isolated to facilitate proper maintenance, service, and or removal.
- 2.06 REFRIGERANT CIRCUITS:
- A. Refrigerant: Type as indicated on Drawings.
 - B. Refrigerant Type: R-134a, R-410a. Classified as Safety Group A1 according to ASHRAE 34.
 - C. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
 - D. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor[suction] and discharge shutoff valves, a liquid-line shutoff valve, a [replaceable-core]filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

E. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

2.07 EVAPORATOR:

A. Shell-and-tube design.

1. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - a. Shell Material: Carbon steel.
 - b. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
 - c. Fluid Nozzles: Terminated with [mechanical-coupling] [flanged] end connections for connection to field piping.
 - d. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
 - e. Retain subparagraph below if required to mount evaporator remote from chiller.
 - f. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

B. Flooded Shell & Tube Design:

1. The evaporator is to be of shell and tube construction. Evaporator to be constructed of a single shell. Evaporator to be of flooded type with refrigerant surrounding the tubes and water passing through the tubes. Tubes to be enhanced and rifled. Internal intermediate tube supports, liquid eliminator baffle plate, pressure relief vent, water drains and vents required. Pressure relief to be spring loaded self-seating type in accordance to ASHRAE 15 standard. Evaporator to be pressure tested at a test pressure of 1.1 times the operating pressure however no less than 100 PSIG. Evaporator, water boxes, suction piping, and any other component subject to condensate shall be insulated with a UL recognized 3/4" or 1-1/2" closed cell insulation. All joints and seams to be sealed so a vapor barrier is created. Factory mounted differential pressure transmitters required for flow safety. Paddle flow switches are not acceptable. Heat Exchangers to feature enhanced and rifled individual tubes. Tubes shall be individually replaceable. Tubes shall be mechanically rolled into steel tube sheets and sealed with Loctite® or equivalent sealant. Waterside to be designed to a minimum of 150 psig or 300 psig, whichever is specified. Piping connections to be either mechanical grooved connection or flange, whichever is specified. Evaporator tubes shall be serviceable without removing water connections when an even number of passes is specified.

C. Brazed Plate Design Note to editor: The brazed plate is typically used with modular style chillers. Airstack scroll based chillers are typical.

1. Each evaporator shall be a brazed-plate heat exchanger constructed of 316 stainless steel and be designed, tested, and stamped in accordance with UL 1995 Heating and Cooling Equipment.

2.08 AIR-COOLED CONDENSER:

- A. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).
 - 1. Construct coil casing of galvanized or stainless steel.
 - 2. Construct coils of copper tubes mechanically bonded to aluminum, aluminum with precoated epoxy-phenolic, or copper fins.
 - 3. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
 - 4. Optional: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
 - B. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
 - C. Fan Motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
 - D. Fan Guards: Steel safety guards with corrosion-resistant coating.
- 2.09 ELECTRICAL POWER:
- A. Not all manufacturers provide all features indicated in subparagraphs below. Verify availability with manufacturers.
 - B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field-power connection to chiller.
 - C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
 - D. Wiring shall be numbered and color-coded to match wiring diagram.
 - E. Install factory wiring outside of an enclosure in a raceway.
 - F. Field-power interface shall be to NEMA KS1, heavy-duty, fused disconnect switch.
 - 1. Disconnect means shall be interlocked with door operation.
 - 2. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
 - G. Provide each motor with overcurrent protection.
 - H. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
 - I. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.
 - J. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
 - 1. Power unit-mounted controls where indicated.
 - 2. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
 - K. Control Relays: Auxiliary and adjustable time-delay relays.

- L. For chiller electrical power supply, indicate the following:
 - 1. Current and phase to phase for all three phases.
 - 2. Voltage, phase to phase, and phase to neutral for all three phases.
 - 3. Three-phase real power (kilowatts).
 - 4. Three-phase reactive power (kilovolt amperes reactive).
 - 5. Power factor.
 - 6. Running log of total power versus time (kilowatt-hours).
 - 7. Fault log, with time and date of each.
 - 8. <Insert features>.

- M. Variable Speed Drive:
 - 1. The chiller shall be equipped with a variable speed drive. Please refer to section 2.03 B for compressor requirements. The variable speed drive to utilize Insulated Gate Bi-Polar Transistors. Variable speed drive to create simulated AC voltage as required by the motor connected to it.
 - 2. Variable Speed drive in conjunction with the compressors inlet guide vanes will be controlled via compressor microprocessor to optimally match the lift and load requirements.
 - 3. The compressor circuit is required to have a line reactor and circuit breaker.

2.10 CONTROLS:

- A. Standalone and microprocessor based.
- B. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure.
- C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
 - 1. Revise list below to suit Project. Verify availability of displayed information with chiller manufacturers. Some information may be optional; other information may not be available from all listed manufacturers.
 - 2. Date and time.
 - 3. Operating or alarm status.
 - 4. Operating hours.
 - 5. Outdoor-air temperature if required for chilled-water reset.
 - 6. Temperature and pressure of operating set points.
 - 7. Entering and leaving temperatures of chilled water.
 - 8. Refrigerant pressures in evaporator and condenser.
 - 9. Saturation temperature in evaporator and condenser.
 - 10. No cooling load condition.
 - 11. Elapsed time meter (compressor run status).
 - 12. Pump status.
 - 13. Antirecycling timer status.

14. Percent of maximum motor amperage.
 15. Current-limit set point.
 16. Number of compressor starts.
- D. Control Functions:
1. Revise list below to suit Project. Verify availability; functions may vary among manufacturers and models.
 2. Manual or automatic startup and shutdown time schedule.
 3. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on [return-water] [outdoor-air] [space] temperature.
 4. Current limit and demand limit.
 5. External chiller emergency stop.
 6. Antirecycling timer.
 7. Automatic lead-lag switching.
 8. Variable evaporator flow.
 9. Thermal storage.
- E. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Low evaporator pressure or high condenser pressure.
 2. Low chilled-water temperature.
 3. Refrigerant high pressure.
 4. High or low oil pressure.
 5. High oil temperature.
 6. Loss of chilled-water flow.
 7. Control device failure.
- F. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
- G. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
- H. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
- I. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
1. Monitoring: On-off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt-hours).
 2. Control: On-off operation, chilled-water discharge temperature set-point adjustment, electrical power demand limit.

3. Protocol Interface points: Provide the chiller with a BAS communication interface coordinated with the building automation system. The appropriate modular plug-in is to be provided to enable the unit controller to communicate using standardized protocols, either LONTALK, Modbus or BACnet without a separate gateway.
 - a. The Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARKS ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
 - 1) BACnet MS/TP master (Clause 9)
 - 2) BACnet IP, (Annex J)
 - 3) BACnet ISO 8802-3, (Ethernet)
 - 4) LONMARKS FTT-10A. The unit controller shall be LONMARKS® certified.
 - b. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
 - c. For chillers communicating over a LONMARKS network, the corresponding LONMARKS external Interface File (XIF) shall be provided with the chiller submittal data.
 - d. ASHRAE 135 (BACnet)] Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.
 - 1) All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE 135-2020). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.11 INSULATION:

- A. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C534, Type I for tubular materials and Type II for sheet materials.
- B. Second option in first subparagraph below may not be offered by all listed manufacturers.
- C. Thickness: 1-1/2 inches (38 mm).
 1. Factory-applied insulation over cold surfaces of chiller components.
 2. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
 3. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

2.12 REQUIRED OPTIONS:

- A. Retain one or more of four subparagraphs below to add features furnished by chiller manufacturer.

- B. Consult manufacturers for flow-switch requirements. Some chiller models of some manufacturers have other forms of protection built into chiller design and do not require flow switches. Some manufacturers offer factory-mounted flow switches as standard. Carrier, for example, factory mounts a thermal-dispersion-type flow switch on some models.
- C. Factory-furnished, chilled-water flow switches for field installation.
- D. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
- E. Before retaining spring isolators for use on rotary-screw chillers, consult a vibration consultant to verify suitability.
- F. Factory-furnished neoprene or spring isolators for field installation.
- G. Retain subparagraph below only if requested by Owner. Servicing of chiller by unqualified personnel is not recommended by chiller manufacturers and may void chiller warranty.
- H. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.
- I. Hot Gas Bypass: allows unit operation to 10 percent of full load. Includes factory-mounted hot gas bypass valve, solenoid valve, and manual shutoff valve for each circuit. Shall be ready for field piping according to manufacturer instructions.
- J. Low Ambient Control: Fan VFD allows unit operation down to -10°F (-23.3°C).
- K. High ambient control box for operation in ambient temperatures from 105°F to 125°F.
- L. Ground Fault Protection: Factory installed circuit breaker to protect equipment from damage from line-to-ground fault currents less than those required for conductor protection.
- M. Phase loss with under/over voltage protection and with LED indication of the fault type to guard against compressor motor burnout.
- N. Factory-mounted thermal dispersion type flow switch.
- O. Field-mounted, paddle type, chilled water flow switch field wired to the control panel.
- P. Evaporator inlet strainer, 40-mesh with extension pipe and Victaulic couplings.
- Q. Screw compressor sound reduction package.
 - 1. Each rotary screw compressor will include a muffler as standard and each condenser fan will be low noise as standard.
 - 2. In addition to the sound reducing features on the standard unit, add insulating sound material to the suction and discharge lines of each refrigerant circuit and reduces the maximum speed of each condenser fan.
 - 3. In addition to the sound reducing features above, add a flexible, metallic connection at the suction and discharge of each compressor, a pre-formed 'sound box' encapsulating each compressor and reduces the maximum speed of each condenser fan. The fan speed can be set for sound reduction from 100% 60% of maximum fan speed.

- R. Remote operator interface panel (field-wired).
- S. 115V GFI convenience outlet.
- T. BAS interface module, factory mounted.

2.13 SOURCE QUALITY CONTROL

- A. Perform functional tests of chillers before shipping.
- B. Factory run test each air-cooled chiller with water flowing through evaporator. Test the following conditions:
 - 1. Design conditions indicated.
 - 2. Chiller operating at calculated worst-case sound condition.
 - 3. At four point(s) of varying part-load performance to be selected by Owner at time of test.
 - 4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- C. For chillers located outdoors, rate sound power level according to AHRI 370.

2.14 OPTIONAL FACTORY-INSTALLED PUMP PACKAGE

- A. The pump package shall be factory mounted and wired on the chiller. The chiller controller shall provide a pump start/stop signal when operation is required. On dual pump systems, the chiller shall provide also automatic alternating of pump starts and duty/standby functionality. The package shall be equipped with:
 - 1. Single Pump Model 4380: single spring inside-seal, vertical, in-line, radially split-case pump, serviceable without breaking pipe connections. The motor and pump rotating assembly shall be serviceable without removing the pump casing from the line, or,
 - 2. Dual Pumps in a Single Casting Model 4392: single-spring inside-seal vertical, in-line, radially split-case pumps, mounted in a common casing with a common inlet connection and outlet connection and including a flapper valve to prevent recirculation when only one pump is operating. An isolation valve shall be included to allow one pump to operate when the other is removed. The pumps shall be designed for duty/standby, not parallel operation.
- B. Pump package shall also be equipped with:
 - 1. "Y" type inlet strainer.
 - 2. Combination triple-duty outlet valve having a drip-tight discharge shutoff valve, non-slam check valve, and flow throttling valve.
 - 3. Combination suction guide with flow stabilizing outlet vanes and stainless steel strainer with a disposable fine-mesh strainer for start-up.
 - 4. Factory power and control wiring from the AGZ chiller to the pump package control panel.
 - 5. Flow switch mounted and wired.
 - 6. Interconnecting Schedule 40 piping with Victaulic couplings.
 - 7. Insulation of all cold surfaces.
- C. Package Options
 - 1. Water pressure gauges on the pump suction and discharge.

2. Expansion tank with size increments from 4.4 to 90 gallons, field installed (small sizes can be factory mounted).
3. Air separator with air vent, field installed.
4. Pump VFD for variable chilled water flow capability.
5. The VFD shall be completely sensorless requiring no field installation or wiring of sensors. The drive shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date. The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between auto control modes and manual control. The drive shall incorporate a USB port for direct connection to a PC and an RS485 connection with Modbus RTU protocol. The built-in BAS mode shall be equipped with the same protocol as the chiller.
6. Control software shall provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure system feedback sensor. Control mode setting and minimum / maximum head and flow set-points shall be set at the factory and be user adjustable via the inbuilt programming interface.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine chillers before installation. Reject chillers that are damaged.
- B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
 1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CHILLER INSTALLATION

- A. Install chillers on support structure indicated.
- B. See Section 230548 Vibration Isolation and Seismic Restraint for Piping, Ductwork, and Equipment for required vibration isolation requirements.
- C. Concrete base and concrete materials and installation requirements are specified in Division 3.
 1. Concrete Bases: Anchor chiller mounting frame to concrete base.
 - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

- d. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - e. Cast-in-place concrete materials and placement requirements are specified in Division 3.
- D. Vibration Isolation: See Section 230548 "Vibration Isolation for Piping, Ductwork and Equipment".
- E. Buffer Tank Provision: If chilled water system total volume is less than 6 gallons per ton of capacity (10 gallons for low temperature/ice storage systems) or less than a 3 minute total system changeover flow, install a buffer tank sized as needed to achieve the minimum total system water volume. See Section 232113: Hydronic Piping, Valves and Specialties for tank specification.
- F. Equipment Mounting:
- 1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Isolation for Piping, Ductwork, and Equipment".
- G. Maintain manufacturer's recommended clearances for service and maintenance.
- H. Charge chiller with refrigerant and fill with oil if not factory installed.
- I. Install separate devices furnished by manufacturer and not factory installed.

3.03 CONNECTIONS

- A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping, Valves and Specialties." Drawings indicate general arrangement of piping, fittings, and specialties
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Make connections to chiller with a flanges or mechanical couplings.
- D. Connect each chiller drain connection with a union and drain pipe. Extend the pipe, full size of connection, to approved receptor drain. Provide a shutoff ball valve at each connection.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
 - 3. Verify that pumps are installed and functional.
 - 4. Verify that thermometers and gages are installed.
 - 5. Operate chiller for run-in period.
 - 6. Check bearing lubrication and oil levels.
 - 7. For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.
 - 8. Verify proper motor rotation.

9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
 - B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
 - C. Prepare test and inspection startup reports.
- 3.05 COMMISSIONING:
- A. This contractor shall provide a startup test plan for chiller(s) coordinating with the chiller manufacturer, control contractor, and electrical contractor. Plan shall include test schedules, and names and titles of the test personnel who will be participating in the commissioning tests.
- 3.06 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION

SECTION 23 64 16
WATER COOLED CHILLERS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- A. This Section includes water-cooled, electric-motor driven, water chillers with the following features:
 - 1. Microprocessor-controlled liquid chiller shall use a hermetic compressor.
 - 2. Microprocessor-based BACnet BTL certified controls.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230903: Refrigerant Detection and Alarm for refrigerant monitors, alarms, supplemental equipment, and ventilation equipment interlocks.

1.04 DESIGN REQUIREMENTS

- A. General: Provide a complete water-cooled hermetic centrifugal compressor water-chilling package as specified herein. Machine shall be provided according to referenced standards Section 1.2. In general, unit shall consist of a compressor, condenser, evaporator, lubrication system, starter and control system.
- B. Note: Chillers shall be charged with a refrigerant not subject to the Montreal Protocol and the U. S. Clean Air Act.
- C. Performance: Refer to schedule on the drawings. The chiller shall be capable of stable operation to ten percent of full load with standard AHRI entering condensing water relief without the use of hot gas bypass.
- D. Efficiencies: Performance of the submitted equipment shall meet and/or exceed the scheduled equipment performance in the construction documents schedule of equipment. Manufacturers listed in the specification are listed as acceptable subject to submittal of equipment with identical or superior performance of the scheduled equipment. Minimum efficiencies shall meet or exceed the values required by the local energy code.
- E. Seismic: Chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces noted elsewhere in these specifications and the unit will be fully operational after the seismic event.

- F. Acoustics: Sound pressure levels for the complete unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to AHRI Standard 575-87. Data shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.

1. Octave Band

Octave Band	63	125	250	500	1000	2000	4000	8000	dB

1.05 REFERENCES

- A. Comply with the following codes and standards:
1. AHRI 550/590: Certify chiller according to AHRI 590 certification program.
 2. AHRI Rating: Rate water chiller performance according to requirements in AR"1 506/110, "Water Chilling Packages Using the Vapor Compression Cycle."
 3. NFPA 70
 4. NEC
 5. OSHA
 6. ASME Section VIII: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- B. ANSI/ASHRAE 15: Safety code for mechanical refrigeration.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.06 DEFINITIONS

- A. EER: Energy-efficiency ratio.
- B. IPLV: Integrated part-load value.

1.07 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans drawn to scale and coordinated with the following:
1. Structural supports.
 2. Piping roughing-in requirements.
 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control test reports.
- F. Startup service reports.
- G. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

1.08 QUALITY ASSURANCE

- A. AHRI Certification: Signed by manufacturer certifying compliance with requirements in AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Compressor impellers shall be dynamically balanced and over-speed tested by the manufacturer at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels, oil pressures, and temperatures are within acceptable limits.
- F. Each compressor assembly shall be proof tested at a minimum 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture.
- G. Entire chiller assembly shall be proof tested at 204 psig (1406 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture on the refrigerant side. The water side of each heat exchanger shall be hydrostatically tested at 1.3 times rated working pressure.
- H. Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be stored and handled in accordance with manufacturer's instructions.
- B. Unit shall be shipped with all piping and control wiring factory installed.
- C. Unit shall be shipped charged with oil and full charge of refrigerant or a nitrogen holding charge as specified on the equipment schedule.
- D. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, chiller model number, chiller serial number, and refrigerant used.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.11 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Provide with five (5) year warranty on compressors and refrigerant.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work. This includes but is not limited to the following:
 - 1. Daikin (McQuay)
 - 2. Trane
 - 3. Carrier Corporation
 - 4. YORK International Corporation

2.02 MANUFACTURED UNIT

- A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.
- B. Retain first subparagraph below if limited space is available for installation.
- C. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
- D. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.
- E. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.03 REFRIGERATION

- A. Refrigerant:
 - 1. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
 - 2. Refrigerant by compressor type:

Compressor	Acceptable Refrigerant
Centrifugal	R-123, R-134a
Screw	R-134a
Scroll	R-410a
Reciprocating	R-22

3. R-123; ASHRAE 34, Class B1 or R-134a; ASHRAE 34, Class A1.
- B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
- C. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. For Chillers Using R-123: Provide either a rupture disc constructed of frangible carbon, spring-loaded, pressure relief valve; single- or multiple-reseating type.
 3. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.
- D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
- E. Refrigerant Isolation for Chillers Using R-134a: Factory install isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.
- F. Purge System:
1. For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables including, but not limited to, water, water vapor, and noncondensable gases.
 2. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
 3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
 4. Construct components of noncorrodible materials.
 5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
 6. Efficiency of not more than 0.02 lb of refrigerant per pound of air (9 g of refrigerant per gram of air) when rated according to AHRI 580.

7. Operation independent of chiller per ASHRAE 147.

G. Positive-Pressure System:

1. For chillers operating at sub-atmospheric pressures (using R-123 refrigerant), factory install an automatic positive-pressure system.
2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (3 kPa) adjustable up to a pressure that remains within the vessel design pressure limits.
3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.04 COMPRESSOR DRIVE ASSEMBLY

A. Maglev or oil free centrifugal compressor

1. Compressor-drive assembly
 - a. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
 - 1) Provide oil-free compressor technology using either a permanent magnet synchronous motor, magnetic bearings, integral variable frequency controller, and digital electronic controls or other alternative technology.
 - b. Compressor:
 - 1) Casing: Cast iron, precision ground.
 - 2) Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
 - c. Drive: Direct-drive, hermetic design using an electric motor as the driver.
 - d. Compressor Motor:
 - 1) Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated or permanent magnet motor.
 - 2) Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - 3) Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
 - 4) Provide motor with thermistor or RTD to monitor temperature and report information to chiller control panel.
 - e. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
 - 1) Overspeed Test: 25 percent above design operating speed.
 - f. Service: Easily accessible for inspection and service.
 - 1) Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
 - 2) Provide lifting lugs or eyebolts attached to casing.
 - g. Economizers: For multistage chillers, provide interstage economizers.

- h. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.
 - 1) Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - 2) Operating Range: From 100 to 15 percent of design capacity.
 - 3) Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 F (1.4 C) for each 10 percent in capacity reduction
 - 4) Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
 - i. Oil Lubrication System: Shall not be required for operation.
- B. Oil-lubricated centrifugal compressor
- 1. The compressor shall be a hermetic centrifugal. {Request for substitution of open drive chiller must include an air handler sized for mechanical room cooling.}
 - 2. The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed a level of 0.14 IPS.
 - 3. Movable inlet guide vanes shall accomplish unloading. Compressors using an unloading system that requires penetrations through the compressor housing or linkages, or both that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of any compressor seals. A statement of inclusion must accompany any quotations.
 - 4. If the compressor is not equipped with guide vanes for each stage and movable discharge diffusers, then furnish hot gas bypass and select chillers at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.
 - 5. For open motor units, an oil reservoir shall collect any oil and refrigerant that leaks past the seal. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing. Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the refrigerating unit for a period of 5 years from the initial start-up including parts and labor to replace a defective seal and any refrigerant required to trim the charge original specifications.
 - 6. The chiller should be able to unload to 15% of design tonnage with constant entering condenser water temperature.
 - 7. Motor: Motor shall be 460 volt, 3 phases, 60 hertz with six terminal posts for wye delta starting. Continuous duty for minimum of 15 years with a maximum number of starts expected of 15,000 and a minimum delay between starts of 30 minutes.
 - 8. Lubrication System: The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. Coolers located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement oil pump shall be powered through the unit control transformer.
- C. Screw compressor
- 1. Compressor:
 - a. Description: [Hermetic] [or] [open], positive displacement, and oil lubricated.

- b. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
 - c. Rotors: Manufacturer's standard one-, two-, or three-rotor design.
 - d. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
 - e. Seals: Seal drive assembly to prevent refrigerant leakage.
2. Compressor Motor:
- a. Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required to suit chiller energy efficiency indicated.
 - b. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - c. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
 - d. First option in first subparagraph below is standard offering and is suitable for most indoor applications. Retain second, third, or fourth option if chiller is installed outdoors or regularly exposed to high levels of moisture. Consult manufacturer.
 - e. For chillers with open drives, provide motor with [open-dripproof] [weather-protected, Type I] [weather-protected, Type II] [totally enclosed] enclosure.
 - f. Provide motor with thermistor or RTD in [single motor winding] [each of three-phase motor windings] to monitor temperature and report information to chiller control panel.
 - g. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
 - h. Subparagraph below is not required for most indoor applications; retain if required.
 - i. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.
3. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
- a. Overspeed Test: 25 percent above design operating speed.
4. Service: Easily accessible for inspection and service.
- a. Verify availability of requirements in two subparagraphs below with manufacturer.
 - b. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
 - c. Provide lifting lugs or eyebolts attached to casing.
 - d. Capacity Control: Modulating slide-valve assembly or port unloaders combined with [a variable frequency controller, if applicable, and]hot-gas bypass, if necessary, to achieve performance indicated.
 - e. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - f. Standard operating range varies among manufacturers. Not all listed manufacturers comply with options in first subparagraph below without hot-gas bypass. Consult manufacturer for requirements.
 - g. Operating Range: From 100 to [20] [15] [10] [5] [zero] <Insert number> percent of design capacity.

1. Description: Positive-displacement direct drive with semihermetically sealed and accessible bolted casings.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: 1750 rpm for 60-Hz applications.
4. Retain first option in first subparagraph below for water chillers with multiple compressors. Retain second option if Project requires capacity control to near-zero cooling load.
5. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling[of multiple compressors][, plus hot-gas bypass]. Compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
6. Oil Lubrication System: Automatically reversible, positive-displacement pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
7. Vibration Isolation: Mount individual compressors on either neoprene or spring isolators.
8. Retain subparagraph below for projects with stringent acoustical requirements. Sound-reduction packages are typically an optional feature.
9. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.
10. Compressor Motors:
 - a. Hermetically sealed and cooled by refrigerant suction gas.
 - b. High-torque, four-pole induction type with inherent thermal-overload protection on each phase.
 - c. Compressor Motor Controllers:
 - 1) Retain one of two subparagraphs below. Part-wind start is not available on all sizes of water chillers.
 - 2) Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
 - 3) Part-Wind Start: NEMA ICS 2, Class A, reduced voltage, nonreversing.

2.05 EVAPORATOR – SHELL AND TUBE

- A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
- B. Evaporator shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 100 psig. Provide intermediate tube supports at a maximum of 24 inch spacing.
- C. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
- D. Designed to prevent liquid refrigerant carryover from entering compressor.
- E. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
- F. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
 2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
 3. Material: Copper
 4. Nominal OD: 3/4 inch (19 mm)
 5. Minimum Wall Thickness: 0.025 inch (0.6 mm)
 6. External Finish: Manufacturer's standard.
 7. Internal Finish: Enhanced or smooth].
- G. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
- H. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
- I. Water Box:
1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 2. Standard type for water box with piping connections. Standard type for water box without piping connections.
 3. Provide water boxes with lifting lugs or eyebolts.
 4. Retain one of first two subparagraphs below for special applications.
 5. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
 6. Thermistor or RTD temperature sensor factory installed in each nozzle.
 7. Fit each water box with 3/4-inch (19-mm) drain connection at low point and vent connection at high point, each with threaded plug.
- J. Additional Corrosion Protection:
1. Electrolytic corrosion-inhibitor anode.
 2. Retain one of two subparagraphs below.
 3. Coat wetted surfaces with a corrosion-resistant finish.
 4. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
- 2.06 EVAPORATOR – BRAZED FRAME NOTE TO EDITOR: THIS CONSTRUCTION IS TYPICAL OF MODULAR CHILLERS LIKE MULTISTACK.
- A. Each evaporator shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser. The evaporator heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.
- 2.07 CONDENSER – SHELL AND TUBE
- A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

- B. Condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 100 psig. Provide intermediate tube supports at a maximum of 24 inch spacing.
- C. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
- D. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
- E. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
- F. Tubes:
 - 1. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - 2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
 - 3. Tube materials vary among manufacturers and chiller models; verify availability with manufacturer. First option in first subparagraph below is current standard of listed manufacturers.
 - 4. Material: [Copper] [Copper-nickel alloy] [Stainless steel] [Titanium] [Copper, copper-nickel alloy, stainless steel, or titanium] <Insert material>.
 - 5. Retain one of four options in first subparagraph below. First and fourth options give manufacturer the choice. Second option limits size available from listed manufacturers. Only Trane offers third option.
 - 6. Nominal OD: [Manufacturer's choice] [3/4 inch (19 mm)] [1 inch (25 mm)] [3/4 or 1 inch (19 or 25 mm)].
 - 7. External Finish: Manufacturer's standard.
 - 8. Internal Finish: [Enhanced] [Smooth] [Enhanced or smooth].
- G. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
- H. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
- I. Water Box:
 - 1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - 2. Standard type for water box with piping connections. Standard type for water box without piping connections.
 - 3. Provide water boxes with lifting lugs or eyebolts.
 - 4. Retain one of first two subparagraphs below for special applications.
 - 5. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
 - 6. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - 7. Fit each water box with 3/4-inch (19-mm) drain connection at low point and vent connection at high point, each with threaded plug.

J. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.
2. Retain one of two subparagraphs below.
3. Coat wetted surfaces with a corrosion-resistant finish.
4. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.08 CONDENSER – BRAZED FRAME

- A. Each condenser shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure on the evaporator and 650 psig working pressure on the condenser. The condenser heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

2.09 INSULATION

- A. Closed-cell, flexible elastomeric thermal insulation complying with A STM C 534, Type I for tubular materials and Type II for sheet materials.
- B. Second option in subparagraph below may not be available from all manufacturers as a standard factory option. Consult manufacturer.
- C. Thickness: 3/4 inch (19 mm)
- D. Adhesive: As recommended by insulation manufacturer.
- E. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
 1. Apply adhesive to 100 percent of insulation contact surface.
 2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
 3. Seal seams and joints to provide a vapor barrier.
 4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.10 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Single-point, field-power connection to circuit breaker. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.
- C. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
- D. Control-circuit transformer with primary and secondary side fuses.

- E. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

2.11 MOTOR STARTING AND CONTROL SELECT EITHER MOTOR STARTER OR VFD

A. Motor Starter:

1. Choose either factory mounted or field mounted:
 - a. The main motor starter is to be factory mounted and fully wired to the chiller components and factory tested during the run test of the unit.
-- OR --
 - b. The main motor starter is to be furnished by the chiller manufacturer and shipped loose for floor mounting and field wiring to the chiller package. It shall be free-standing with NEMA-1 enclosure designed for top entry and bottom exit and with front access.
2. For open drive air-cooled motors the chiller manufacturer shall be responsible for providing the cooling of the refrigeration machinery room. The sensible cooling load shall be based on the total heat rejection to the atmosphere from the refrigeration units.
3. General Starter Requirements:
 - a. The starter shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.
 - b. The starter shall be equipped with a redundant motor control relay (MCR). The relay shall interconnect the starter with the unit control panel and directly operate the main motor contactor. The MCR shall constitute the only means of energizing the motor starter.
 - c. The main contactors shall have a normally open auxiliary contact rated at 125VA pilot duty at 115 VAC. An additional set of normally open contacts shall be provided on the MCR.
 - d. There shall be electronic overloads in each phase, which will permit continuous operation at 107% of the rated load amps of each motor. The overloads shall have a must-trip setting of 125% of the rated load amps. Overloads shall be manual reset and shall de-energize the main contactors when the overcurrent occurs. The overloads shall be adjustable, have manual reset, be ambient compensated, and set for Class 10 operation.
 - e. Each starter shall have a current transformer and adjustable voltage dropping resistor(s) to supply a 5.0 VAC signal at full load to the unit control panels.
 - f. Each starter shall be equipped with a line-to-115 VAC control transformer, fused in both the primary and secondary, to supply power to the control panels, oil heaters and oil pumps.
 - g. Each starter shall include the following:
 - 1) Under voltage/over voltage and phase failure and reversal protection
 - 2) Load break disconnect switch
 - 3) Current limiting power fuses
 - h. Main Control Relays
 - 1) A motor control relay shall be provided to interlock the starter with the chiller. The relay shall constitute the only means of energizing the motor starter. No other devices (manual or automatic) with the capability of energizing the starter can be used. The starter is to be controlled by the unit microprocessor.

- i. Motor Protection and Overloads
 - 1) The starter shall include overload protection functions. These controls include:
 - (a) Solid state overload (overcurrent) protection
 - (b) Phase unbalance protection
 - (c) Phase reversal and phase loss protection.
 - (d) Adjustable overload to closely match motor performance
 - (e) Three current transformers to measure motor current and a fourth current transformer for input to the chiller microprocessor.
- j. Undervoltage (UV) Relay
 - 1) The undervoltage relay is an adjustable three-phase protection system that is activated when the voltage falls below a predetermined safe value and is factory set at 85% of nominal.
- k. Control Voltage Transformer
 - 1) The starter is to be provided with a 3KVA control transformer with both secondary and primary fuses to supply control power to the chiller.
- l. Additional Standard Components
 - 1) Mechanical type solderless connectors to handle wire sizes indicated by the NEC.
 - 2) Three vertically mounted current limiting power fuse blocks (fuses included)
 - 3) Magnetic three-pole, vacuum break contactor
 - 4) Single phase control circuit transformer
 - 5) Vertically mounted control circuit primary current limiting fuses
 - 6) Current transformers
 - 7) Control circuit terminal blocks and secondary fuses
 - 8) Phase failure and reversal relay
- 4. Low Voltage (200 through 600 volts): Low Voltage (200 through 600 volts) motor controllers are to be continuous duty AC magnetic type constructed according to NEMA standards for Industrial Controls and Systems (ICS) and capable of carrying the specified current on a continuous basis. The starter shall be: Select one of the following two starter options:
 - a. Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

-- OR --
 - b. Wye-Delta Closed Transition - The starter shall be equipped with properly sized resistors to provide a smooth transition. The resistors shall be protected with a transition resistor protector, tripping in a maximum of two seconds, locking out the starter, and shall be manually reset. A clearly marked transition timer shall be adjustable from 0 to 30 seconds or a current sensing device shall initiate transition when the starting current drops to 90% of the unit RLA.

--OR--
- 5. Medium Voltage (601 through 7200 volts). The starter shall be:

- a. Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

--OR--

- b. Across-the-Line type with primary contactor allowing locked rotor amps to reach the motor when energized, including items a through f above.

--OR--

- c. Autotransformer type factory wired to the 65% tap with drawout magnetic, three-pole, vacuum break shorting contactor, drawout magnetic, two-pole, vacuum break starting contactor, and open delta starting auto-transformer factory set at 65%. Including items a through F except for isolating safety switch in lieu of load break disconnect switch in item f ii.

--OR--

- d. Primary Reactor type with drawout magnetic, three-pole, vacuum break shorting assembly, and three-phase starting reactor, factory set at the 65% tap. All medium and high voltage starters shall have the following components:

B. Variable Frequency Controller

1. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
2. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.
4. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.
5. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
 - a. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
 - b. Regulator shall provide full digital control of frequency and voltage.
 - c. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Operating Requirements:
 - a. Input AC Voltage Tolerance: [460-V ac, plus 10 percent or 506 V maximum] <Insert voltage and tolerance>.

- b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - c. Capable of driving full load, without derating, under the following conditions:
 - 1) Ambient Temperature: 0 to 50 deg C.
 - 2) Relative Humidity: Up to [90] [95] percent (noncondensing).
 - 3) Altitude: [3300 feet (1005 m)] [6600 feet (2010 m)].
 - d. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - e. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
 - f. Overload Capability: 1.05 times the full-load current for 7 seconds.
 - g. Starting Torque: As required by compressor-drive assembly.
 - h. Speed Regulation: Plus or minus 1 percent.
 - i. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
 - j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
 - k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
9. Internal Adjustability Capabilities:
- a. Minimum Output Frequency: 6 Hz.
 - b. Maximum Output Frequency: 60 Hz.
 - c. Acceleration: 2 seconds to a minimum of 60 seconds.
 - d. Deceleration: 2 seconds to a minimum of 60 seconds.
 - e. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.
10. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
- a. Overtemperature.
 - b. Short circuit at controller output.
 - c. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
 - d. Open circuit at controller output.
 - e. Input undervoltage.
 - f. Input overvoltage.
 - g. Loss of input phase.
 - h. Reverse phase.
 - i. AC line switching transients.
 - j. Instantaneous overload, line to line or line to ground.
 - k. Sustained overload exceeding 100 percent of controller rated current.
 - l. Starting a rotating motor.

11. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
12. Automatic Reset and Restart: Capable of [three] <Insert number> restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
13. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overvoltage.
 - d. Line fault.
 - e. Overcurrent.
 - f. External fault.
 - g. Motor speed (percent).
 - h. Fault or alarm status (code).
 - i. DC-link voltage.
 - j. Motor output voltage.
 - k. Input kilovolt amperes.
 - l. Total power factor.
 - m. Input kilowatts.
 - n. Input kilowatt-hours.
 - o. Three-phase input voltage.
 - p. Three-phase output voltage.
 - q. Three-phase input current.
 - r. Three-phase output current.
 - s. Three-phase input voltage total harmonic distortion.
 - t. Three-phase input current total harmonic distortion.
 - u. Output frequency (Hertz).
 - v. Elapsed operating time (hours).
 - w. Diagnostic and service parameters.
14. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
15. Control Signal Interface:
 - a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
16. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.12 CONTROLS

- A. Coordinate this article with Section 230900 Building Automation System Controls.
- B. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- C. Enclosure: Unit mounted, NEMA 250, Type 1 hinged, factory wired with a single-point, field-power connection and a separate control circuit.
- D. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
 - 1. Revise list below to suit Project. Verify availability of displayed information with chiller manufacturers. Some information may be optional; other information may not be available from all listed manufacturers.
 - 2. Date and time.
 - 3. Operating or alarm status.
 - 4. Fault history with not less than last 10 faults displayed.
 - 5. Set points of controllable parameters.
 - 6. Trend data.
 - 7. Operating hours.
 - 8. Number of chiller starts.
 - 9. Outdoor-air temperature or space temperature if required for chilled-water reset.
 - 10. Entering- and leaving-fluid temperatures of evaporator and condenser.
 - 11. Difference in fluid temperatures of evaporator and condenser.
 - 12. Fluid flow of evaporator and condenser.
 - 13. Fluid pressure drop of evaporator and condenser.
 - 14. Refrigerant pressures in evaporator and condenser.
 - 15. Refrigerant saturation temperature in evaporator and condenser shell.
 - 16. Compressor refrigerant suction and discharge temperature.
 - 17. Compressor bearing temperature.
 - 18. Motor bearing temperature.
 - 19. Motor winding temperature.
 - 20. Oil temperature.
 - 21. Oil discharge pressure.
 - 22. Phase current.
 - 23. Percent of motor rated load amperage.
 - 24. Phase voltage.
 - 25. Demand power (kilowatts).
 - 26. Energy use (kilowatt-hours).
 - 27. Power factor.

28. For chillers equipped with variable frequency controllers and harmonic filters, include the following:
 - a. Output voltage and frequency.
 - b. Voltage total harmonic distortion for each phase.
 - c. Supply current total demand distortion for each phase.
 - d. Inlet vane position.
 - e. Controller internal ambient temperature.
 - f. Heatsink temperature.
 29. Purge suction temperature if purge system is provided.
 30. Purge elapsed time if purge system is provided.
- E. Control Functions:
1. Manual or automatic startup and shutdown time schedule.
 2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water temperature.
 3. Current limit and demand limit.
 4. Condenser-fluid temperature.
 5. External chiller emergency stop.
 6. Variable evaporator flow.
 7. Thermal storage.
 8. Heat reclaim.
- F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Low evaporator pressure, temperature, pressure or temperature; high condenser pressure.
 2. Low evaporator fluid temperature.
 3. High compressor-discharge temperature.
 4. Loss of condenser-fluid flow.
 5. Loss of evaporator fluid flow.
 6. Motor overcurrent.
 7. Motor overvoltage.
 8. Motor undervoltage.
 9. Motor phase reversal.
 10. Motor phase failure.
 11. Sensor- or detection-circuit fault.
 12. Processor communication loss.
 13. Motor controller fault.
 14. Extended compressor surge.
 15. Excessive air-leakage detection for chillers using R-123 refrigerant.

- G. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
- H. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
- I. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
- J. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.
- K. Retain paragraph below if chiller controls interface with the BAS. Coordinate with Section 230900 "Instrumentation and Control for HVAC."
- L. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
 - 1. Provide the chiller with a BAS communication interface coordinated with the building automation system. The appropriate modular plug-ins is to be provided to enable the unit controller to communicate using standardized protocols, either LONTALK, Modbus or BACnet without a separate gateway.
 - 2. The Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARKS® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
 - a. BACnet MS/TP master (Clause 9)
 - b. BACnet IP, (Annex J)
 - c. BACnet ISO 8802-3, (Ethernet)
 - d. LONMARKS FTT-10A. The unit controller shall be LONMARKS® certified.
 - 3. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
 - 4. For chillers communicating over a LONMARKS network, the corresponding LONMARKS external Interface File (XIF) shall be provided with the chiller submittal data.
 - 5. ASHRAE 135 (BACnet)] Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.
 - a. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2020). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.13 FINISH

- A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
 - 1. Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils (0.10 mm).

2. Paint surfaces that are to be insulated before applying the insulation.
3. Paint installed insulation to match adjacent uninsulated surfaces.

- B. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

2.14 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for evaporator and condenser and verify field-mounting location before installation.
2. Pressure Differential Switches:
 - a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
 - b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
 - c. Set Point: Screw type, field adjustable.
 - d. Electrical Connections: Internally mounted screw-type terminal blocks.
 - e. Switch Enclosure: NEMA 250, Type 4
 - f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
 1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

- A. See Section 230548 Vibration Isolation for required vibration isolation requirements.
- B. Where Section 230548 calls for chillers to be mounted to a concrete base coordinate with concrete materials and installation requirements as specified in Division 3.
 1. Concrete Bases: Anchor chiller mounting frame to concrete base.
 - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

- c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - e. Cast-in-place concrete materials and placement requirements are specified in Division 3.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
 - D. Charge water chiller with refrigerant if not factory charged.
 - E. Buffer Tank Provision: If chilled water system total volume is less than 6 gallons per ton of capacity (10 gallons for low temperature/ice storage systems) or less than a 3 minute total system changeover flow, install a buffer tank sized as needed to achieve the minimum total system water volume. See Section 232113: Hydronic Piping, Valves and Specialties for tank specification.
 - F. Install separate devices furnished by manufacturer.

3.03 CONNECTIONS

- A. Chilled and condenser-water piping installation requirements are specified in Section 232113 HVAC Piping, Valves and Specialties. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water chillers to allow service and maintenance.
- C. Evaporator Connections: refer to piping diagrams for required valves and fittings.
- D. Condenser Connections: refer to piping diagrams for required valves and fittings
- E. Install shutoff valves at chilled-water and condenser-water inlet and outlet connections.
- F. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions.
- G. Ground water chillers according to Division 26 "Grounding and Bonding."
- H. Connect wiring according to Division 26 "Conductors and Cables."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.

3. Verify that thermometers and gages are installed.
 4. Operate water chiller for run-in period according to manufacturer's written instructions.
 5. Check bearing lubrication and oil levels.
 6. Verify that refrigerant pressure relief is vented outside.
 7. Verify proper motor rotation.
 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
 10. Verify and record performance of water chiller protection devices.
 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 12. Prepare a written startup report that records results of tests and inspections.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.05 CHILLER FAULT CODES AND ALARMS

- A. The chiller manufacturer shall provide a listing of all chiller operational codes, alarms, and fault codes sorted into three categories for use by the BAS system and building operator prior to controls programming, start-up, and Commissioning. The categories shall be as follows:
1. Yellow: for information only. (No action needed by building operator).
 2. Orange: fault codes and alarms with automatic reset. (For information and BAS system logging only. No action required by building operator)
 3. Red: fault codes and alarms with manual reset needed. (Action required by building operator.)
 4. The intent of this requirement is to assist the BAS controls programmer and Building operator minimize nuisance alarms and prioritize the chiller diagnostic information in a usable fashion

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Refer to Division 1 Section "Demonstration and Training".

END OF SECTION

SECTION 23 64 27

WATER TO WATER HEAT PUMP/CHILLER

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Screw chillers
 - 2. Charge of refrigerant and oil.
 - 3. Controls and control connections.
 - 4. Chilled water connections.
 - 5. Starters.
 - 6. Electrical power connections.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230716: Equipment Insulation
- D. Section 230900: Building Automation System (BAS) Controls
- E. Section 233113: Air Distribution
- F. Section 232123: Pumps and Hydronic Specialties
- G. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide chiller units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide chiller units conforming to the requirements of the latest addition of the following:

1. American National Standards Institute (ANSI):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 207 - Refrigerant-Containing Components and Accessories, Nonelectrical
 - d. 303 - Refrigeration and Air Conditioning Condensing and Compressor Units
 - e. 465 - Central Cooling Air Conditioners
 - f. 900 - Test Performance of Air Filter Units
2. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 210 - Unitary Air Conditioning Equipment
 - b. 270 - Sound Rating of Outdoor Unitary Equipment
 - c. 550/590 - Centrifugal or Rotary Screw Water-Chilling Packages
 - 1) Submit certified data for performance at 25, 50, 75 and 100 percent of full load capacity.
3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Code for Mechanical Refrigeration
4. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code
 - a. Section VIII D1 - Rules for Construction of Pressure Vessels including Addendums
 - b. Section VIII D2 - Rules for Construction of Pressure Vessels including Addendums
 - c. Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide unit insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code (NEC)
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL. Chillers shall be constructed in accordance with UL-465 "Central Cooling Air Conditioners". Listing by Electrical Testing Laboratories (ETL) with an ETL label may also be acceptable.

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 1. The proposed substitution does not affect dimensions shown on drawings.
 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.

4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. **Shop Drawings:** Submit manufacturer's shop drawings indicating dimensions, weight loading, required clearances, methods of assembly of components, and location and size of each field connection.
- C. **Maintenance Data:** Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.
- D. **Wiring Diagrams:** Submit manufacturer's electrical requirements for power wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Differentiate between factory-installed and field-installed wiring.
- E. **Commissioning Test Plan:** Submit test plan for chillers. Plan shall include test schedules, and names and titles of the test personnel who will be participating in the commissioning tests. The test personnel must be employees of the chiller manufacturer or the manufacturer's designated representatives. Plan shall include false loading of chillers, if the anticipated building loads at the time of test do not meet capacity requirements. Submittals shall have detailed layout for temporary equipment, if such equipment is needed, even if it is not specified or shown on the Drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. **Rigging:** Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Provide with five (5) year warranty on compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Climatemaster, Mammoth, Florida Heat Pump.

2.02 GENERAL:

- A. Furnish and install Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.
- B. Water-to-Water Heat Pumps:
 - 1. Units shall be supplied completely factory built for an entering source water temperature range from 20° to 110°F (-6.7° to 43.3°C) and entering (heating) load water temperature range from 60° to 120°F (15.6° to 48.9°C) or entering (cooling) load water temperature range of 50° to 90°F (10.0° to 32.2°C) as standard. Equivalent units from other manufacturers can be proposed provided approval to bid is given 10 days prior to bid closing. All equipment listed in this section must be rated and certified in accordance with American Refrigeration Institute / International Standards Organization (ARI / ISO) and Canadian Standards Association (CSA-US). The units shall have ARI / ISO and CSA-US labels. All units shall be fully quality tested by factory run testing under normal operating conditions and water flow rates as described herein perform detailed heating and cooling mode tests, and quality cross check all operational and test conditions to pass/fail data base. Detailed report card will ship with each unit displaying all test performance data. Note: If unit fails on any cross check, system shall not be allowed unit to ship. Serial numbers will be recorded by factory and furnished to contractor on report card for ease of unit warranty status. Units tested without water flow are not acceptable
 - 2. Basic Construction:
 - a. All units must have a minimum of three access panels for serviceability of compressor compartment. Units having only one access panel to compressor shall not be acceptable.
 - b. The heat pumps shall be fabricated from heavy gauge G90 galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection. All interior surfaces shall be lined with ½ inch (12.7mm) thick, dual density, 1-3/4 lb/ft³ (28 kg/m³) acoustic type glass fiber insulation. Insulation placement shall be designed in a manner that will eliminate any exposed edges.
 - c. Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22.
 - d. Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper IPT fittings, and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Water connections that protrude through the cabinet or require the use of a backup wrench shall not be allowed. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature.

- e. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor. Unit(s) shall have exterior indicator lights showing, 1) compressor operation (on/off) and 2) unit "fault" status. Contractor shall be responsible for providing control circuitry and indicator lights for units not providing this feature.
3. Refrigerant Circuit:
 - a. Units shall have a sealed refrigerant circuit including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, a reversing valve, coaxial (tube in tube) refrigerant to water heat exchangers, and safety controls including a high pressure switch, low pressure switch (loss of charge), and low water temperature sensors. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Units shall have 2 independent refrigeration circuits. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit.
 - b. Hermetic compressors shall be internally sprung. The compressor(s) shall have a dual level vibration isolation system. The compressor(s) will be mounted on computer selected vibration isolation springs to a large heavy gauge compressor mounting tray plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation.
 - c. Compressor shall have thermal overload protection. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 PSIG (3101 kPa) working refrigerant pressure and 450 PSIG (3101 kPa) working water pressure.
 - d. Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 110°F (-6.7° to 43.3°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function.
 4. Electrical:
 - a. A control box shall be located within the unit compressor compartment and shall contain a 50VA transformer, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote aquastat / sensor. Two compressor units shall have a solid-state time delay relay and random start to prevent both compressors from starting simultaneously.
 5. Solid State Control System (CXM):
 - a. Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:
 - 1) Anti-short cycle time delay on compressor operation.
 - 2) Random start on power up mode.
 - 3) Low voltage protection.
 - 4) High voltage protection.
 - 5) Unit shutdown on high or low refrigerant pressures.

- 6) Unit shutdown on low water temperature.
 - 7) Option to reset unit at thermostat or disconnect.
 - 8) Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
 - 9) Ability to defeat time delays for servicing.
 - 10) Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, freeze protection, condensate overflow, and control voltage status.
 - 11) The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
 - 12) 24V output to cycle a motorized water valve or other device with compressor contactor.
 - 13) Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
 - 14) Source water coil low temperature sensing (selectable for water or anti-freeze).
 - 15) Load water coil low temperature sensing.
6. Protocol interface board. Available protocols are BACnet MS/TP, Modbus, or Johnson Controls N2. The choice of protocol shall be field selectable/changeable via the use of a simple selector switch. Protocol selection shall not require any additional programming or special external hardware or software tools. This will permit all units to be daisy chain connected by a 2-wire twisted pair shielded cable. The following points must be available at a central or remote computer location:
- a. Source leaving water temperature
 - b. Load leaving water temperature
 - c. Command of space temperature setpoint
 - d. Cooling status
 - e. Heating status
 - f. Low temperature sensor alarm
 - g. Low pressure sensor alarm
 - h. High pressure switch alarm
 - i. Hi/low voltage alarm
 - j. Unoccupied / occupied command
 - k. Cooling command
 - l. Heating command
 - m. Fault reset command
 - n. Itemized fault code revealing reason for specific shutdown fault (any one of 7) This option also provides the upgraded 75VA control transformer with load side short circuit and overload protection via a built in circuit breaker.
- C. Warranty: The manufacturer shall warranty equipment for a period of 12 months from start up or 18 months from shipping (whichever occurs first).

PART 3 EXECUTION

3.01 INSTALLATION

- A. All equipment, unless otherwise shown or noted, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
- B. Align chiller package on concrete foundations.
- C. Install unit on vibration isolators.
- D. Connect to chilled and condenser water piping.
- E. Arrange piping for easy dismantling to permit tube cleaning and removal of tubes.
- F. Provide an approved self contained breathing apparatus located convenient to the equipment room for emergency use.
- G. Route pressure relief pipes to the outside per the Mechanical Code.
- H. All control wiring necessary to interface starter and chiller control panel is the responsibility of this contractor.
- I. Division 26 is responsible for main chiller power brought to starter and starter to motor power. All other power wiring necessary to operate equipment provided with and necessary to the operation of the chiller shall be provided by this contractor. This includes wiring for oil pumps, purge units or other ancillary chiller equipment.
- J. Provide a lighted pilot emergency shutdown switch and wiring located with 10 feet on the exterior of the entry to shut down the chiller and initiate refrigeration exhaust fan (REF) operation.
- K. Insulate water box.

3.02 SEISMIC REQUIREMENTS

- A. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of 100% gravity also acting at the center of gravity.
- B. Piping and ductwork connecting to equipment shall be seismically braced per SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems".
- C. The seismic calculations shall be the responsibility of contractor.

3.03 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify chiller mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

END OF SECTION

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SECTION 23 65 00

COOLING TOWERS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Cooling towers.
 - 2. Fluid coolers.
 - 3. Controls and control connections.
 - 4. Condenser water connections.
 - 5. Makeup water and drainage connections.
 - 6. Automatic chemical control system.
 - 7. Starters and variable frequency drives
 - 8. Electrical power connections.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods.
- B. Section 230593: Testing, Adjusting and Balancing.
- C. Section 230900: Building Automation System (BAS) Controls.
- D. Section 232113: Hydronic Piping, Valves and Specialties.
- E. Section 232123: Hydronic Pumps.
- F. Section 232500: HVAC Water Treatment.
- G. Section 232501: Non-Chemical HVAC Water Treatment.
- H. Section 232535: Open Condenser Loop Soft Water Treatment.
- I. Section 232613: Water Filtration for Open-Loop Hydronic Systems.
- J. Division 26: Electrical.

1.04 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. **Structural Performance:** Tower and tower support structure shall withstand the effects of locally defined gravity loads, seismic loads, dead loads, live loads, winds loads and stresses within limits and under conditions indicated according to the Building Code and ASCE 7. Coordinate support structure requirements with Structural Engineer.
- C. **Codes and Standards-**Provide components conforming to the requirements of the latest addition of the following:
 - 1. **Factory Mutual Approval (where required by Owner or AHJ):** The tower shall be listed in the current FM Approval Guide and conform to the FM Approval Standard for Cooling Towers, Class Number 4930 that is approved for use without sprinkler systems. The tower shall have successfully passed full scale fire testing, static and cyclic wind pressure testing, large missile impact testing and structural design evaluation as administered by FM Approvals.
 - 2. **American National Standards Institute (ANSI):**
 - a. A58.1: Minimum Design Loads for Buildings and Other Structures.
 - 3. **Cooling Tower Institute (CTI):**
 - a. ATC-105: Standard Specifications for Thermal Testing of Wet/Dry Cooling Towers.
 - b. ATC-128: Code for Measurement of Sound from Water Cooling Towers.
 - c. ATC-140: Isokinetic Drift Measurement Test Code for Water Cooling Towers.
 - d. STD-111: Standard Specifications Gear Speed Reducers for Application on Water-Cooling Towers.
 - e. STD-131: Fiberglass-Reinforced Plastic Panels.
 - f. STD-201: Standard for Thermal Performance Certification of Evaporative Heat Rejection Equipment.
 - g. STD-201RS: Standard for Certification of Water Cooling Tower Thermal Performance.
 - h. WTG-142: Treatment of Galvanized Cooling Tower to Prevent White Rust.
 - i. ESG-151: Variable Frequency Drive Application Guidelines for Cooling Towers.
 - 4. **National Electrical Manufacturers Association (NEMA):** Provide electrical components which comply with NEMA Standards.
 - 5. **National Fire Protection Association (NFPA):**
 - a. 70: National electrical Code.
 - 6. **Occupational Safety and health Administration (OSHA):** Construct stairways and ladders in conformance with OSHA requirements.
 - 7. **Underwriters Laboratories (UL):** Provide electrical components which comply with UL Standards.
 - 8. **Energy Compliance:** Equipment shall meet and/or exceed the minimum requirements of ASHRAE 90.1 Energy Standards for Buildings or local State Energy Code, as applicable.
- D. **Certification:** Submit certification of tower conformance to CTI design and testing standards, CTI Certification Standard STD-201.

- E. Design and certify towers for a wind load of 30 pounds per square foot.
- F. Drift Eliminators: Achieve drift reduction to 0.002 percent (maximum) of the recirculated water volume for counter-flow towers and to 0.005 percent (maximum) for cross-flow towers.

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 - 1. The proposed substitution does not affect dimensions shown on drawings.
 - 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 - 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 - 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions. Include the following:
 - 1. Maximum flow rate.
 - 2. Minimum flow rate.
 - 3. Drift loss as percent of design flow rate.
 - 4. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
 - 5. Performance curves for the following:
 - a. Varying entering-water temperatures from design to minimum.
 - b. Varying ambient wet-bulb temperatures from design to minimum.
 - c. Varying water flow rates from design to minimum.
 - d. Varying fan operation (off, minimum, and design speed).
 - 6. Fan airflow, brake horsepower, and drive losses
 - 7. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
 - 8. Electrical power requirements for each cooling tower component requiring power.
- B. Shop Drawings: Submit manufacturer's shop drawings of assemblies, control panels, sections and elevations, unit isolation, valves, alarms, methods of assembly of components, and location and size of each field connection. Include the following:

- a Assembled unit dimensions.
 - b Weight (shipping and operating) and load distribution
 - c Required clearances for maintenance and operation.
 - d Sizes and locations of piping and wiring connections.
 - e Wiring Diagrams: For power, signal, and control wiring.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.
 - D. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.
 - E. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
- C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Motor/Drive System: Provide five (5) year comprehensive warranty against basin leaks, materials and workmanship including motor, fan, bearings, mechanical support, sheaves, bushing and belts.

PART 2 PRODUCTS

2.01 INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

- A. Description: Induced-draft, counterflow cooling tower that is factory fabricated and assembled. Refer to equipment schedule on drawings for additional requirements.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Evapco, Inc., #AT and #UT Series
 2. Baltimore Aircoil Co., #PT2 Series
 3. Marley Cooling Tower Co.
- C. Casing: Structural steel frame constructed of heavy-gage steel angles and channels. Casing panels shall be constructed of the following:
1. Galvanized steel complying with ASTM A653/A653M, G235 (Z600) coating designation, or,
 2. 304 Stainless Steel, or,
 3. 316 Stainless Steel, or,
 4. Fiberglass-reinforced polyester with UV inhibitors, or,
 5. Galvanized steel panels protected with a thermosetting hybrid polymer or epoxy.
- D. Casing features:
1. Panels: Shall totally encase the fill media to protect the fill from damage due to direct atmospheric contact.
 2. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
 3. Joints: Sealed watertight.
 4. Welded Connections: Continuous and watertight.
 5. Rigging Supports: For handling cooling towers at construction site.
 6. Access Doors: Access doors shall be provided and located throughout the tower, to allow easy access and maintenance to the bottom pan section, motor, and media. Access doors shall provide a watertight seal.
- E. Basin:
1. Makeup water connection.
 2. Overflow connection.
 3. Sloped basin to low drain connection in sump. Outlet connection shall be beveled for welding, grooved for mechanical coupling or bolt hole circle for flat face flange.
 4. Removable strainer with openings smaller than nozzle orifices.
 5. Removable anti-vortexing device to prevent air entrainment
 6. Collection Basin: 304 or 316 Stainless steel panels and structural members.
- F. Fan:
1. Axial propeller, individually adjustable wide chord blade extruded aluminum installed in a closely fitter cowl with venture air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
 2. Axial propeller, one piece heavy duty FRP hub and blade construction. Galvanized steel closely fitter fan cowl with venture air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.

- G. Water Distribution System: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, non-clogging spray nozzles.
1. Pipe Material: Schedule 40 PVC or stainless steel.
 2. Nozzles: Removable plastic, brass, or ceramic nozzles. Confirm pressure-drop information.
- H. Fill material:
1. Fill Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84; and fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- I. Drift Eliminator: Reduced allowed maximum drift rate of 0.001% of circulated water volume.
1. Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84.
- J. Louver material: Frames shall be constructed of G-235 galvanized steel or Type 316 stainless steel with easy removal of screens. Louvers shall be "sight tight" to completely block direct sunlight from entering and water from splashing out of the tower
1. Louver Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84 mounted in removable (galvanized or stainless frames or the same material as the basin).
- K. Makeup Water Control: (Note to Editor: Select one of the water level control options below based on project requirements. Mechanical float is typical, simple and acceptable.)
1. Mechanical Water-Level Control: Manufacturer's standard brass mechanical makeup water valve, and plastic or bronze float with an adjustable linkage, or
 2. Electronic Water-Level Control: Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.

2.02 INDUCED-DRAFT, CROSS-FLOW COOLING TOWERS

- A. Description: Induced-draft, cross-flow cooling tower that is factory fabricated and assembled.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baltimore Aircoil Co., #1500 and #3000 Series
 2. Marley Cooling Tower Co.
- C. Casing: Structural steel frame constructed of heavy-gage steel angles and channels. Casing panels shall be constructed of the following:
1. Galvanized steel complying with ASTM A653/A653M, G235 (Z600) coating designation, or,
 2. 304 Stainless Steel, or
 3. 316 Stainless Steel, or,
 4. Fiberglass-reinforced polyester with UV inhibitors, or,
 5. Galvanized steel panels protected with a thermosetting hybrid polymer or epoxy.
- D. Casing features:

1. Panels: Shall totally encase the fill media to protect the fill from damage due to direct atmospheric contact.
 2. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
 3. Joints: Sealed watertight.
 4. Welded Connections: Continuous and watertight.
 5. Rigging Supports: For handling cooling towers at construction site.
 6. Access Doors: Access doors shall be provided and located throughout the tower, to allow easy access and maintenance to the bottom pan section, motor, and media. Access doors shall provide a watertight seal.
- E. Basin:
1. Makeup water connection.
 2. Overflow connection.
 3. Sloped basin to low drain connection in sump. Outlet connection shall be beveled for welding, grooved for mechanical coupling or bolt hole circle for flat face flange.
 4. Removable strainer with openings smaller than nozzle orifices.
 5. Removable anti-vortexing device to prevent air entrainment
 6. Collection Basin: 304 or 316 Stainless steel panels and structural members.
- F. Fan:
1. Axial propeller, individually adjustable wide chord blade extruded aluminum installed in a closely fitted cowl with venturi air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
 2. Axial propeller, one piece heavy duty FRP hub and blade construction. Galvanized steel closely fitted fan cowl with venturi air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
- G. Water Distribution System: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, non-clogging spray nozzles.
1. Pipe Material: Schedule 40 PVC or stainless steel.
 2. Nozzles: Removable plastic, brass, or ceramic nozzles. Confirm pressure-drop information.
- H. Fill material:
1. Fill Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84; and fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- I. Drift Eliminator: Reduced allowed maximum drift rate of 0.001% of circulated water volume.
1. Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84.
- J. Louver material: Frames shall be constructed of G-235 galvanized steel or Type 316 stainless steel with easy removal of screens. Louvers shall be "sight tight" to completely block direct sunlight from entering and water from splashing out of the tower.

1. Louver Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84 mounted in removable (galvanized or stainless frames or the same material as the basin).

K. Makeup Water Control:

1. Mechanical Water-Level Control: Manufacturer's standard brass mechanical makeup water valve, and plastic or bronze float with an adjustable linkage, or
2. Electronic Water-Level Control: Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.

2.03 FORCED-DRAFT, CROSS-FLOW COOLING TOWERS

A. Description: Forced-draft, cross-flow cooling tower that is factory fabricated and assembled.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Baltimore Aircoil Co., #FXT Series
2. Marley Cooling Tower Co.

C. Casing: Structural steel frame constructed of heavy-gage steel angles and channels. Casing panels shall be constructed of the following:

1. Galvanized steel complying with ASTM A653/A653M, G235 (Z600) coating designation, or,
2. 304 Stainless Steel, or,
3. 316 Stainless Steel, or,
4. Fiberglass-reinforced polyester with UV inhibitors, or,
5. Galvanized steel panels protected with a thermosetting hybrid polymer or epoxy.

D. Casing features:

1. Panels: Shall totally encase the fill media to protect the fill from damage due to direct atmospheric contact.
2. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
3. Joints: Sealed watertight.
4. Welded Connections: Continuous and watertight.
5. Rigging Supports: For handling cooling towers at construction site.
6. Access Doors: Access doors shall be provided and located throughout the tower, to allow easy access and maintenance to the bottom pan section, motor, and media. Access doors shall provide a watertight seal.

E. Basin:

1. Makeup water connection.
2. Overflow connection.
3. Sloped basin to low drain connection in sump. Outlet connection shall be beveled for welding, grooved for mechanical coupling or bolt hole circle for flat face flange.
4. Removable strainer with openings smaller than nozzle orifices.
5. Removable anti-vortexing device to prevent air entrainment

6. Collection Basin: 304 or 316 Stainless steel panels and structural members.
- F. Fan:
1. Axial propeller, individually adjustable wide chord blade extruded aluminum. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
 2. Axial propeller, one piece heavy duty FRP hub and blade construction. Galvanized steel closely fitter fan cowl with venture air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
- G. Water Distribution System: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, non-clogging spray nozzles.
1. Pipe Material: Schedule 40 PVC or stainless steel.
 2. Nozzles: Removable plastic, brass, or ceramic nozzles. Confirm pressure-drop information.
- H. Fill material:
1. Fill Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84; and fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- I. Drift Eliminator: Reduced allowed maximum drift rate of 0.001% of circulated water volume.
1. Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84.
- J. Louver material: Frames shall be constructed of G-235 galvanized steel or Type 316 stainless steel with easy removal of screens. Louvers shall be "sight tight" to completely block direct sunlight from entering and water from splashing out of the tower.
1. Louver Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84 mounted in removable (galvanized or stainless frames or the same material as the basin).
- K. Makeup Water Control:
1. Mechanical Water-Level Control: Manufacturer's standard brass mechanical makeup water valve, and plastic or bronze float with an adjustable linkage, or
 2. Electronic Water-Level Control: Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.

2.04 FORCED-DRAFT, COUNTERFLOW COOLING TOWERS

- A. Description: Forced-draft, counterflow cooling tower that is factory fabricated and assembled.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baltimore Aircoil Co., #VT0 or #VT1 Series
 2. Evapco Inc., #LSTE or #LPY Series
 3. Marley
- C. Casing: Structural steel frame constructed of heavy-gage steel angles and channels. Casing panels shall be constructed of the following:

1. Galvanized steel complying with ASTM A653/A653M, G235 (Z600) coating designation, or,
 2. 304 or 316 Stainless Steel, or,
 3. Fiberglass-reinforced polyester with UV inhibitors, or,
 4. Galvanized steel panels protected with a thermosetting hybrid polymer or epoxy.
- D. Casing features:
1. Panels: Shall totally encase the fill media to protect the fill from damage due to direct atmospheric contact.
 2. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
 3. Joints: Sealed watertight.
 4. Welded Connections: Continuous and watertight.
 5. Rigging Supports: For handling cooling towers at construction site.
 6. Access Doors: Access doors shall be provided and located throughout the tower, to allow easy access and maintenance to the bottom pan section, motor, and media. Access doors shall provide a watertight seal.
- E. Basin:
1. Makeup water connection.
 2. Overflow connection.
 3. Sloped basin to low drain connection in sump. Outlet connection shall be beveled for welding, grooved for mechanical coupling or bolt hole circle for flat face flange.
 4. Removable strainer with openings smaller than nozzle orifices.
 5. Removable anti-vortexing device to prevent air entrainment
 6. Collection Basin: 304 or 316 Stainless steel panels and structural members.
- F. Fan:
1. Belt-driven, hot-dip galvanized steel, forward-curved centrifugal fan; statically and dynamically balanced.
- G. Water Distribution System: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, non-clogging spray nozzles.
1. Pipe Material: Schedule 40 PVC or stainless steel.
 2. Nozzles: Removable plastic, brass, or ceramic nozzles. Confirm pressure-drop information.
- H. Fill material:
1. Fill Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84; and fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- I. Drift Eliminator: Reduced allowed maximum drift rate of 0.001% of circulated water volume.
1. Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84.

- J. Louver material: Frames shall be constructed of G-235 galvanized steel or Type 316 stainless steel with easy removal of screens. Louvers shall be "sight tight" to completely block direct sunlight from entering and water from splashing out of the tower.
1. Louver Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84 mounted in removable (galvanized or stainless frames or the same material as the basin).
- K. Makeup Water Control:
1. Mechanical Water-Level Control: Manufacturer's standard brass mechanical makeup water valve, and plastic or bronze float with an adjustable linkage, or
 2. Electronic Water-Level Control: Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.
- L. Inlet Screen Material:
1. Galvanized steel mesh mounted in removable frames, or,
 2. Hot-dip galvanized steel mesh with polymer coating mounted in removable frames, or,
 3. Stainless-steel mesh mounted in removable frames.
- M. Discharge Hood Material:
1. Galvanized steel according to ASTM A653/A653M, G235 (Z600) coating designation, or,
 2. Hot-dip galvanized steel, or,
 3. Stainless steel.

2.05 EVAPORATIVE FLUID COOLER

- A. Description: Evaporative closed circuit fluid cooler that is factory fabricated and assembled.
1. Closed-circuit fluid cooler, induced-draft, vertical counterflow with axial fan at discharge.
 2. Closed-circuit fluid cooler, forced-draft with centrifugal fan in the dry airstream.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Evapco, Inc, #ATW or #ESW Series
 2. Recold
 3. Baltimore Aircoil Co.
- C. Casing: Structural steel frame constructed of heavy-gage steel angles and channels. Casing panels shall be constructed of the following:
1. Galvanized steel complying with ASTM A653/A653M, G235 (Z600) coating designation, or,
 2. 304 or 316 Stainless Steel, or,
 3. Fiberglass-reinforced polyester with UV inhibitors, or,
 4. Galvanized steel panels protected with a thermosetting hybrid polymer or epoxy.
- D. Casing features:
1. Panels: Shall totally encase the fill media to protect the fill from damage due to direct atmospheric contact.

2. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
 3. Joints: Sealed watertight.
 4. Welded Connections: Continuous and watertight.
 5. Rigging Supports: For handling cooling towers at construction site.
 6. Access Doors: Access doors shall be provided and located throughout the tower, to allow easy access and maintenance to both the bottom pan section and the upper coil and spray section. Access doors shall provide a watertight seal.
- E. Basin:
1. Makeup water connection.
 2. Overflow connection.
 3. Sloped basin to low drain connection in sump. Outlet connection shall be beveled for welding, grooved for mechanical coupling or bolt hole circle for flat face flange.
 4. Removable strainer with openings smaller than nozzle orifices.
 5. Collection Basin: 304 or 316 Stainless steel panels and structural members.
- F. Fan:
1. Axial propeller, individually adjustable wide chord blade extruded aluminum installed in a closely fitted cowl with venturi air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
 2. Axial propeller, one piece heavy duty FRP hub and blade construction. Galvanized steel closely fitted fan cowl with venturi air inlet. Fan guard shall be heavy gauge hot dip galvanized steel or 304 stainless steel.
- G. Water Distribution System: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, non-clogging spray nozzles.
1. Pipe Material: Schedule 40 PVC or stainless steel.
 2. Nozzles: Removable plastic, brass, or ceramic nozzles. Confirm pressure-drop information.
- H. Fill material:
1. Fill Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84; and fabricated, formed, and installed by manufacturer to ensure that water breaks up into droplets.
- I. Drift Eliminator: Reduced allowed maximum drift rate of 0.001% of circulated water volume.
1. Drift-Eliminator Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84.
- J. Louver material: Frames shall be constructed of G-235 galvanized steel or Type 316 stainless steel with easy removal of screens. Louvers shall be "sight tight" to completely block direct sunlight from entering and water from splashing out of the tower.
1. Louver Material: PVC or FRP, resistant to rot, decay, and biological attack; with maximum flame-spread rating of five according to ASTM E84 mounted in removable (galvanized or stainless frames or the same material as the basin).
- K. Makeup Water Control:

1. Mechanical Water-Level Control: Manufacturer's standard brass mechanical makeup water valve, and plastic or bronze float with an adjustable linkage, or
 2. Electronic Water-Level Control: Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.
- L. Heat Transfer Coil:
1. Coil(s) shall be fabricated as a complete assembly. The tubes shall be arranged in a self-spacing, staggered pattern in the direction of airflow for maximum heat transfer efficiency and minimum pressure drop, without the use of additional spacers between the coil tubes. The coil(s) shall be sloped for draining.
 2. Material shall be:
 - a. Prime-coated steel tube and sheet with outer surface of tubes and sheets hot-dip galvanized after fabrication, or,
 - b. Copper tube with stainless-steel sheet, or,
 - c. Stainless-steel tube and sheet.
- M. Circulation Pump: Close-coupled, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service. Motor shall be TEFC style with epoxy or polyurethane coating.
- N. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
1. NEMA 250 Type 4 enclosure with removable internally mount backplate.
 2. Control-circuit transformer with primary and secondary side fuses.
 3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
 4. Microprocessor-based controller for automatic control of fan and spray pump based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
 5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
 6. Provide basin electric/electronic level controller, as option to mechanical makeup.
 7. Electric basin heaters with temperature control and low-water-level safety switch for each cell.
 8. Single-point, field-power connection to a fused disconnect switch for each cell.
 - a. Branch power circuit to each motor and electric basin heater and to controls.
 - b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
 9. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid tight conduit.
 10. Visual indication of status and alarm for each motor.
 11. Audible alarm and silence switch.
 12. Visual indication of elapsed run time, graduated in hours for each motor.
 13. Cooling tower shall have hardware to enable BAS to remotely monitor and display the following:

- a. Operational status of each motor.
- b. Cooling tower leaving-fluid temperature.
- c. Fan vibration alarm.
- d. Collection basin water-level alarms.

O. Dampers:

1. Closure Dampers: Many times, during unit shutdown with fan and pump off, it is desirable to conserve the amount of heat loss from the process fluid. For those applications, closure dampers are available for this installation at the air discharge of the closed circuit cooler. The damper package is designed to prevent convective air flow through the idle unit thus minimizing the heat loss. Installation of the closure dampers requires all wiring to be completed in the field. Electric actuator is factory mounted. Controls and wiring are to be supplied by others. The damper actuator should be wired into the field control system to allow the dampers to fully open when the fan cycles on and close when the fan cycles off. The actuator requires a 115 volt power supply.

2.06 MOTORS

- A. Refer to Section 230500 Basic HVAC Materials and Methods for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, 1.15 service factor, continuous duty, Design B.
- C. Use motor below for operation in dry, moist or corrosive atmosphere.
 1. Enclosure Type: Totally enclosed, fan cooled (TEFC) inverter ready premium efficiency.
- D. Use motor below when located in cooling-tower discharge airstream.
 1. Enclosure Type: Totally enclosed, air over (TEAO) inverter ready premium efficiency.
- E. Motor speed: inverter ready controlled by variable frequency drive (VFD).
- F. Direct Drive: The fan drive shall be mounted on the motor in a direct drive configuration.
- G. Belt Drive: Power Band Belt designed for 150% of the motor nameplate HP.
 1. Belt: Multi-groove, solid back V-belt type neoprene reinforced with polyester cord.
 2. Sheaves: Aluminum alloy if located inside the airstream.
 3. Bearings: Heavy duty, self-aligning pillow block bearings with lubrication lines extended to side access door. Minimum L10 life for bearings shall be 75,000 hours. Provide extended grease lines and fittings.

2.07 VIBRATION SWITCH

- A. Provide one mechanical vibration switch for each drive to de-energize fan motors if excessive vibration occurs per mechanical code. All electrical wiring and conduit to be provided by Division 26, coordinate accordingly. Manufacturers: Metrix #5550 or #5550G Series.
- B. Cast aluminum enclosure with epoxy coating with the following features:
 1. NEMA 250, Type 4 or 4X, depending on manufacturer mounting location.
 2. Amplitude Range: 0 to 16 g peak with 1 g resolution adjustment setpoints.

3. Frequency Range: 0 – 60 Hz (0 – 3600 rpm).
 4. Manual local reset.
 5. Temperature operating range of -40°F to 158°F.
 6. Voltage and amperage as required by motor requirements.
- C. Mount the vibration switch to be easily accessible for manual resetting.
- D. Cooling tower manufacturer shall recommend switch set point for proper operation and protection. Adjust the switch so that during full speed start-up and under normal conditions the contacts do not trip.

2.08 FLOW METERS

- A. Provide one flow meter to measure the total makeup water quantity to the cooling tower system. Only one meter required to totalize system volume. Individual meters may be installed in makeup water pipe to each cell, if desired, at contractor's option.
- B. Provide one flow meter to measure the total blowdown water quantity from the cooling tower system. Only one meter is required to totalize system volume. Individual meters may be installed in each blowdown pipe from each cell, if desired, at contractor's option. Provide strainer with hose bibb connection on inlet side of meter. Blowdown meter is used for reconciling cycles of concentration and water treatment efficiency.
- C. Bronze body, multi-jet design, with epoxy powder coating. Accuracy +/- 1.5%. Synthetic polymer measuring chambers. Non-wear measurement surfaces. AWWA Standard C-708 compliant. Meter shall be provided with dry contact and 24 volt or 100 mA output signal.
- D. Meter Manufacturer: Carlon Meter #MRS Series, Seametrics #MJ Series

2.09 ELECTRIC WATER LEVEL CONTROLLER AND MAKEUP WATER VALVE

- A. Provide an electric water level controller with five (5) conductivity actuated liquid level probes and normally closed (NC) makeup water solenoid valve. Controller shall be hermetically sealed with an LED status code light when water and/or probes are dirty. All electrical wiring and conduit to be provided by Division 26, coordinate accordingly.
- B. Manufacturer: as provided by cooling tower or equal by Waterline Controls. Mount controller on tower casing as required by manufacturer. Mount near a door or access way for easy adjustment and cleaning.
- C. Features:
1. Enclosure: 2" PVC Schedule 40.
 2. Contact rating: 3 amps, 120 VAC resistive
 3. Temperature rating: -40°F to +150°F ambient
 4. Time delay: 6 seconds +/-
 5. Probes: 1/4" stainless steel
 6. Stilling chamber: 2" PVC pipe.
- D. Controller shall have the following probe levels mounted inside an open PVC stilling chamber:
1. Bottom of stilling chamber shall be mounted within 1" of bottom of basin.

2. Lowest probe #1: Ground. Mounted 1" from bottom of stilling chamber basin.
 3. Second lower probe #2: Low water alarm, connect to BAS
 4. Middle probe #3: Makeup water valve on
 5. Fourth probe #4: Makeup water valve off
 6. Highest probe #5: High water alarm, connect to BAS. Mount 1/2" to 1" below overflow outlet.
- E. Solenoid makeup water valve: Normally closed (NC), 120 VAC slow closing solenoid valve to minimize water hammer. Provide strainer upstream of valve. Connected to controller to open and close based on makeup water probe levels.

2.10 MECHANICAL HIGH WATER LEVEL ALARM AND FLOAT VALVE

- A. Water level control: Brass mechanical makeup water valve and plastic/brass float with an adjustable linkage. Size as required for tower makeup water capacity. Provide integral with cooling tower.
- B. High water level alarm: single level float switch mounted on side of water basin above the overflow water line. Adjust float to close the contact at water level 1/2" (minimum) below overflow outlet invert with signal monitor by building automation system (BAS). Provide watertight sealant at cooling tower penetration.
- C. The high water level switch shall have the following features:
1. 316 Stainless Steel float
 2. 316 Stainless Steel stem
 3. Water slosh shield
 4. Angled support stem with threaded coupling nuts for attachment to side of tower.
 5. 30 VA nominal rating, minimum
 6. 22-gauge lead wires, minimum 24" long
 7. 10 second (adjustable) delay via the BAS
- D. High level water switch manufacturer: Madison #MS5010.

2.11 BASIN HEATERS

- A. Revise ambient conditions as required.
1. Basin-Heater Capacity: Maintain basin water temperature at 40°F (4.4°C) when ambient temperature is 0°F (minus 18°C) and wind velocity is 10 mph (16 km/h).
- B. Select heater type from below.
1. Heater Type: Electric immersion heaters with thermostat and low-water cutout switch, enclosed in weatherproof housing suitable for field wiring.

2.12 MAINTENANCE ACCESS

- A. Internal Working / Service Platforms: Provide a complete internal working platform and ladder system for service of all motor and drive components.
- B. Handrails/Grabrails: Galvanized steel pipe complying with 29 CFR 1910.23. If access to fan deck is required, supply a perimeter handrail with ladder from grade to fan deck.

- C. Ladders: Aluminum, sloped "ships type" with grabrail or vertical complying with 29 CFR 1910.27.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions. Maintain manufacturer's recommended clearances for service and maintenance.
- B. Mount cooling tower on support structure using required anchor bolts. Isolate tower from support structure using rubber or fiberglass isolation pads. Where cooling towers are mounted on a roof provide housed spring vibration isolators to minimize vibration into the building structure. The cooling tower support and anchorage shall be designed and manufactured to withstand, within allowable material stress ranges, both seismic and wind forces as prescribed by the governing building codes. Seismic forces shall be based on the project specific data and height above ground. Wind pressure loads shall be assumed to be as defined in Section 230548 Vibration Isolation for Piping, Ductwork and Equipment and 230549 Seismic Restraint for Piping, Ductwork and Equipment. The unit's anchorage and foundation shall withstand the design forces. Alternately, the contractor may design the support to carry the forces completely independent of the building structure. The tower support and anchoring design shall be certified as in conformance with these requirements by a structural engineer licensed in the jurisdiction having authority.
- C. Connect to condensing water and makeup water piping. Arrange piping for easy dismantling and maintenance. Connect bypass piping as required for startup. Connect equalizer line for multiple cooling tower cells and provide hose bibb drain valve at low point. Provide shutoff valves, balancing valves, and drain valves. Provide multiple mechanical grooved couplings or braided stainless steel flexible connections as required and as shown on drawings to minimize vibration through piping system.
- D. Coordinate with plumbing service for makeup water piping with strainer, makeup water flow totalizing meter, and reduced pressure principal backflow prevention device to makeup water valve sized for peak flow.
- E. Coordinate with plumbing service for blowdown water flow totalizing meter in drain pipe from cooling tower sumps. Provide manual shutoff valve upstream of meter for future maintenance without draining sump. Provide manual balancing valve, with locking position setting, downstream of shutoff valve to allow for setting blowdown flow rate to a flow rate less than the makeup water flow rate to prevent tower sump from draining faster than filling.
- F. Coordinate with controls system for monitoring high water alarm and other control signals to the building automation system.
- G. Install water treatment system.
- H. Connect to electrical service for fan power, vibration switch and electrical valves as scheduled. Refer to Division 26.
- I. Install basin or side stream water filtration system on support structure adjacent to cooling tower/fluid cooler. Install distribution piping and nozzles throughout basin. Provide distribution and nozzle layout drawings for review and approval prior to installation.

- J. Provide a tempered eyewash adjacent to the chemical treatment system, if installed. If the installation is a non-portable type, provide provisions to prevent scalding should the tempering valve fail.
- K. Adjust the vibration switch trip setting. Cooling tower manufacturer shall recommend switch set point for proper operation and protection. Adjust the switch so that during full speed start-up and under normal conditions the contacts do not trip.
- L. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.
- B. Start-up services shall include:
 - 1. Coordinate with controls installers to verify that a 30 second, or greater, time delay is provided for speed changes or for switching between motor operation in multiple fan systems.
 - 2. For systems with variable frequency drives make sure that the minimum speed requirements have been set per the VFD manufacturer.
 - 3. Verify that the condenser water temperature sensor is placed in the proper location to sense the mixed water temperature for fan sequence control and bypass valve operation.
 - 4. Confirm if control programming included fan cycling on a daily basis for 10 minutes, twice a day, as required by manufacturer for local ambient conditions and operational schedule.
 - 5. Verify that water treatment system is installed and operational
 - 6. Verify a water treatment plan has been implemented for passivation of galvanized steel units.
 - a. White rust is a premature failure of the protective zinc layer on hot dip or mill galvanized steel due to improper water treatment control during the start-up of new galvanized equipment.
 - b. Perform local water analysis including water treatment system operation and visual inspections during the first six (6) to twelve (12) weeks of operation. During this passivation period the pH should be maintained between 7 and 8 at all times.
 - c. Changes in water chemistry control may be considered after the passivation process is complete as evidenced by the galvanized surfaces taking on a dull gray color.
 - d. Any changes in the water treatment program or control limits should be made slowly while documenting the impact of changes to the passivated zinc surfaces.

END OF SECTION

SECTION 23 73 12

CUSTOM FACTORY AIR HANDLING UNITS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- 1. Section Includes:
 - a. Variable-air-volume, single-zone air-handling units.
 - b. Variable-air-volume, dual-duct air-handling units.
 - c. Constant-air-volume, single-zone air-handling units.
 - d. Constant-air-volume, multizone air-handling units.
 - e. Constant-air-volume, dual-duct air-handling units.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00: Basic HVAC Materials and Methods
- B. Section 23 05 93: Testing, Adjusting and Balancing
- C. Section 23 09 02: Variable Frequency Drives (VFD)
- D. Section 23 31 13: Air Distribution
- E. Section 23 41 00: Air Filtration
- F. Division 26: Electrical

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of $L/100$, minimum, where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
- C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA):
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans [Unit shall bear AMCA Certified Rating Seal]
 - c. 300 - Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
 - d. 320 - Laboratory Methods of Sound Testing of Fans Using Sound Intensity
 - e. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - f. 500 - Test Method for Louvers, Dampers, and Shutters
 - 2. American National Standards Institute (ANSI):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units
 - 3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 410 - Forced-Circulation Air-Cooling and Air-Heating Coils
 - b. 430 - Central-Station Air-Handling Units
 - 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Code for Mechanical Refrigeration
 - 5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 - 6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
 - 7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
 - 8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.
 - 9. Units shall be listed and labeled by either UL or ETL for air handler construction.

1.06 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 - 1. The proposed substitution does not affect dimensions shown on drawings.
 - 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 - 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 - 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.07 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing
 - 1. Dimensions and weights
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fan including:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - e. Fan assembly vibration and balance test report.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Retain both subparagraphs below if items are furnished as parts of air-handling units.
 - 6. Dampers, including housings, linkages, and operators.
 - 7. Filters with performance characteristics.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.08 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.010 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.011 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Energy Labs, Temtrol, Daikin, Trane, Season 4, United Metal Products, Carrier, or Team Air.

B. By listing various manufacturers does imply that their standard construction is approved or that they are equal. All manufacturers must meet, or exceed, minimum requirements of these specifications and all other standard or optional features provided by the scheduled basis of design air handler.

2.02 GENERAL

A. Any exceptions to the specifications must be clearly defined in the submittal process. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

B. Fabricate draw-thru or blow-thru type air handling units suitable for the scheduled air pressure operation as indicated.

C. Fabricate units with the following features: fan sections as noted; coil section(s); heat recovery sections, mixing section; filter section(s); access section(s); discharge plenum; bell mouth duct connections; variable frequency drives; dampers; lights and vestibules. Fabricate unit in split sections for field assembly if necessary.

- D. Vestibule piping requirements: If shown on plans all piping located within the air handler vestibule is to be supported as specified. Mechanical Contractor to coordinate with air handler supplier to insure that all supports are provided and that adequate structural reinforcement is provided within the air handler to accommodate the operational weight of the pipe supported. The Mechanical Contractor is to provide the air handler manufacturer with an approved shop drawing indicating the location and weight of all equipment and the location of all piping and pipe penetrations located in the air handler vestibule prior to the design of the air handler by the manufacturer.
- E. Fans shall be selected for variable volume operation. The scheduled fan arrangement and unit configuration is the basis of selection. Alternate configurations which are equal or smaller in size and weight, energy and acoustic performance will be considered. Include information indicating pertinent differences, either positive or negative, to base design indicated on documents. Unit component face velocity to remain as designed to conserve motor horsepower. The mechanical contractor and supplier shall bear all costs for redesign of mechanical, plumbing, electrical, structural, architectural and controls that may be associated with the revised configuration. Provide analysis of unit power consumption for code compliance.
- F. Factory fabricate and test air handling units of sizes, capacities, and configuration as indicated and specified.
- G. All major components used to assemble air handling units with the exception of electrical devices, drives, bearings and controls shall be manufactured by the air handler manufacturer.
- H. Motors shall be inverter duty NEMA MG-1 premium efficiency TEFC type. All wiring shall be routed to a single external junction box for each fan section.
- I. Filter section shall include space for face load or side access slide-in filters with 2" or 4" pre-filters and 22" bag type final filters with an average efficiency of 85% per ASHRAE Standard 52-76 test.
- J. Provide measurement arrays as described below.

2.03 UNIT CASING

- A. Walls and roofs shall be constructed of 16-gauge, G90 galvanized steel 4" thick panels. The inner wall shall be a minimum of 22-gauge, solid galvanized steel in all sections except fan inlet and fan section which may be perforated metal if the insulation is faced with foil or plastic scrim for future cleaning. The wall panels shall be insulated with 4", 3.0 lbs/cu. ft rigid neoprene coated insulation. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" x 3/8" tape sealer. Wall seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.
- B. All panels shall be joined using bolts rather than sheet metal screws.
- C. All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable.
- D. Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, additional internal reinforcing shall be added.

E. Provide duct bellmouth fittings where dimensions allow. Provide walk able grates over all duct floor penetrations, maximum pressure loss not to exceed 0.10-inches WC.

F. Acoustical Performance:

1. The housing shall have been tested for acoustical performance by an independent laboratory that is accredited.
2. Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.
 - a. Sound Transmission Loss DB ASTM E-90 & E413-73.

	1	2	3	4	5	6	7	8	
4" Walls	20	20	28	41	51	56	55	57	STC=40

- b. Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83.

	1	2	3	4	5	6	7	8	
4" Walls	.40	.65	1.38	1.28	1.09	1.05	1.02	1.02	NRC=1.20

- d. Submit lab report for approval.

2.04 BASE CONSTRUCTION

A. Units shall be constructed from structural steel C-channel around the perimeter of the unit with intermediate channel, angle or tube supports.

1. Channel bases shall be sized as a function of air handling length as follows:
- 2.

<u>AHU LENGTH</u>	<u>MINIMUM CHANNEL SIZE</u>	
UP to 10	4" x 1-5/8"	(5.4 lbs/Lin.Ft.)
11' to 20'	6" x 2"	(8.2 lbs/Lin.Ft.)
21' to 30'	8" x 2-1/2"	(11.5 lbs/Lin.Ft.)
41' to 50'	12" x 3"	(20.7 lbs/Lin.Ft.)

B. Floor shall be flat, reinforced from below, with all seams continuously welded or floor shall be 0.12" checker plate installed on the base. Drive screw attachment and caulking are not acceptable. The base shall be provided with lifting lugs, a minimum four per unit section. The base shall be insulated tight to the floor with 4", 3.0 lbs/cu. ft fiberglass insulation. The insulation is to be protected with 22-gauge solid galvanized steel liner if the unit floor is exposed in a suspended application. Floors that "oil can" are not acceptable.

C. Floor insulation shall be installed beneath the floor panels in the same manner as the wall and ceiling insulation.

D. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
2. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
3. Depth: A minimum of 2 inches (50 mm) deep.
4. Integral part of floor plating
5. Single-wall 16-gauge, 304 stainless-steel sheet.
6. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on pan. Outlet diameter shall meet minimum sizing requirement of applicable mechanical code.
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
8. The manufacturer shall provide a 1.5" perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.
9. The manufacturer shall provide auxiliary drains in mixing and OSA intake sections.
10. All drain connections on floor mounted air handling units shall terminate at the side of the unit.

E. Maximum base deflection shall be 1/4" on 20-foot unsupported span.

F. Maintenance Rails: Provide overhead lifting rails in sections where motor service will be required.

2.05 INSPECTION AND ACCESS PANELS AND ACCESS DOORS

A. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.

B. Inspection and Access Panels:

1. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
2. Gasket: Neoprene, applied around entire perimeters of panel frames.
3. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

C. Access Doors:

1. Hinges: A minimum of two ball-bearing hinges and two roller cam-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
2. Gasket: Neoprene, applied around entire perimeters of panel frames.
3. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
4. Size: The minimum door clearance shall not be less than 19"x 70" (where unit height permits) and shall be large enough to allow the largest assembled internal component to be removed through the doorway. Internal components must have a door of minimum width to remove the assembled components. Vestibule doors to the exterior shall be 42"x70" (where unit height permits).

D. Locations and Applications:

1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.
2. Fan Section: Doors and inspection and access panels.
3. Access Section: Doors.
4. Coil Section: Inspection and access panel.
5. Damper Section: Doors.
6. Filter Section: Doors large enough to allow periodic removal and installation of filters.
7. Mixing Section: Doors.
8. Humidifier Section: Doors.

2.06 FAN, DRIVE, AND MOTOR SECTION

- A. All fans shall be tested in accordance with AMCA Standard 210-70 Test Code for Air Moving Devices. Fans shall bear the AMCA sticker for both air and sound performance.
- B. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil. Hollow shafts are unacceptable.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range. The critical speed will be based on the top of the speed range for the fans' AMCA class. The lateral static deflection shall not exceed 0.003" per foot of the length of the shaft.
 2. Fan assembly shall be balanced per ISO standard G6.3 with a copy of the balance test data for this project with deflection and critical speed of the shaft and wheel submitted to the engineer
- C. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Horizontal-Flanged, Split Housing: Bolted construction.
 3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
 4. Flexible Connector: Factory fabricated with a fabric strip [3-1/2 inches (89 mm)] [5-3/4 inches (146 mm)] wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet or 0.032-inch- (0.8-mm-) thick aluminum sheets; select metal compatible with casing.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq.m).
 - 2) Fabric Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3) Fabric Service Temperature: Minus 40 to plus 200°F (Minus 40 to plus 93°C).
- D. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

1. Arrangement #4 direct drive fans or AMCA Arrangement #1 either horizontal or vertical as shown on plans and drawings. There shall be no obstructions (i.e., bearings or bearing supports, etc.) at the inlet of the fan. Fan wheel shall be aluminum with aluminum extruded airfoil blades. The fan inlet on plenum fans shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
 2. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.
- E. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws. Aluminum wheel.
- F. Axial Fans: Fan wheel and housing, straightening-vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
- G. Housings: Steel, galvanized steel, or aluminum.
1. Inlet and Outlet Connections: Flanges.
 2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
- H. Fan Array Installation:
1. Provide individual fan back draft dampers and acoustical treatment.
 2. Each fan and motor shall be mounted on an all welded, structural steel, prime coated, internal isolation base with springs selected to provide 99% isolation efficiency with minimum 1" deflection. The inlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection. Provide unit mounted red LED indicator lights to monitor status of all fan array fans, one light per fan. LED to light up indicating loss of respective fan operation. Label lights "FAN FAILURE LIGHTS".
- I. Fan Shaft Bearings:
1. Pre-lubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L10 rated life of 200,000 hours according to ABMA 9. Bearings are to be mounted on the fan structural bracing. Provide extended bearing lubrication lines and zerk fittings to assure accessibility of all lubrication points without disassembly of unit access.
- J. Internal Vibration Isolation and Seismic Control:
1. Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection as stated on the drawings.
 2. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
 3. Fan Assembly Testing:
 - a. Following assembly, the fan balance shall be tested using an electronic balance analyzer with tunable filter and stroboscope.

- b. Direct drive fan wheels shall be factory dynamically balanced and shall meet or exceed guidelines in AMCA 204-96 for Balance Quality and Vibration Levels for Fan Application Category BV-5. Following fan assembly, the complete spring isolated fan assembly shall be tested using an electronic balance analyzer with tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 Axial). The maximum allowable velocity shall not exceed 0.125 inches per second peak amplitude (filter in) on any of 5 readings and shall not exceed .5 mils @ 1170 rpm.
 - c. A copy of the Vibration test report (Vibration Nomograph) shall be provided with the Operation and Maintenance Manual upon request. The fan assembly shall also be vibration tested at design RPM with the spring isolators at the specified deflection, with the tunable filter utilized and frequencies from 500 cpm to 50,000 cpm shall be scanned to detect misalignment, bearing defects, mechanical looseness or foundation weakness. A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted for review.
- K. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
- 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium (TM) efficient motors as defined in NEMA MG1.
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 5. Mount unit-mounted disconnect switches on exterior of unit.

2.07 COILS

- A. Coils shall be designed with counter flow design.
- B. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service and can be removed from the unit through the side. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410-81.
- C. Coils shall be fully enclosed within casing and mounted on primed and painted angle iron racks manufactured to allow coils to slide out individually. Cooling coil racks shall be primed with zinc rich chromate primer. Racks to be designed to allow coil removal from the face of the coil rack. All coils to be removable from either side of the unit by easily removable end panels. End panels that open to coil header and return bend section shall be installed with drive screws and nut-serts to allow access to header and return bend sections for coil inspection without disruption to unit air seal. Individual end panels to be supplied for each coil on the supply and return side of the cabinet to allow single coil piping breakdown for coil removal.
- D. Coil penetrations through cabinet shall be grommeted, sealed airtight by a double escutcheon plate on the exterior of the casing. The escutcheon plate shall have a rolled collar around the pipe opening to protect the pipe and be equipped with an "O" ring rubber gasket between the collar and the pipe to prevent chaffing and provide an air tight seal around the opening. All supply and return connections shall be plainly and permanently marked

- E. Both ends of the coil to be sealed off from the main air stream by full height blank-offs on both the entering-air and leaving-air sides. Blank-offs to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height and width of the coil casing to reduce condensation.
- F. Drain pans shall be continuously welded type 304 stainless steel. Intermediate drain pans shall be interconnected with 1 in. stainless steel drain lines. Drain pans shall be sloped and fully drainable.
- G. All coils shall be fabricated of 5/8" O.D. seamless copper tubing of 0.020 wall thickness minimum mechanically expanded into aluminum fins of 0.008 minimum thickness. All return bends shall be 0.035 copper minimum. Headers shall be of seamless copper. Supply and return connections on each coil shall be raised/lowered a minimum 6" from the bottom/top of the coil to allow room for piping connection hookup between stacked coils, coils near floors and coils near roofs. Each coil shall be provided with capped vent and drain connections extended to the exterior of the cabinet. All coils shall be fully drained with no trapped tubes. Coil casing to be 304 stainless steel for cooling coils and 16-gauge galvanized for heating coils.
- H. Coils shall be hydrostatically tested at 400 psi, and shall be suitable for working pressures and temperature up to 200 psi and 22°F.
- I. Pipe connections shall be on the same end, and shall be threaded. On units with split coils, extend coil pipe connections from coil header through unit side casing using specified pipe material.
- J. Water coils handling recently mixed air, or direct outside air, shall be fully drainable by removing a single threaded plug for each coil row.
- K. Coils indicated as being cleanable shall have either a cleanout plug for each tube or shall have a gasketed removable header cover.
- L. On cooling coils and heat recovery coils using vertically corrugated fins or spiral wound fins, provide moisture eliminators on the downstream side of cooling coils and heat recovery coils when the face velocity exceeds 550 fpm. On cooling coils and heat recovery coils using horizontally corrugated fins, provide moisture eliminators when the face velocity exceeds 525 fpm. Moisture eliminators shall be 304 stainless steel, 3-break type draining directly into the cooling coil drain.
- M. Coils for direct expansion refrigerant applications connected to multiple compressors shall be full face intertwined type.
- N. All coils installed in geographical locations where freezing air temperatures will enter the coil provide relief freeze caps on each coil. Freeze cap fittings shall be brazed construction with screw-on, screw-off removable cap. Install on all return bends on both sides of coil, on applicable headers and tube ends as required. Manufacturer: USA Coil & Air Sentry-Guard.

2.08 FILTERS

- A. Provide pre-filters and front loading final filters.
- B. Filter Gauges
 1. The manufacturer shall provide a DWYER (0-2 inch, 0-500 Pa) magnehelic gauge.
 2. Magnehelic gauges shall be accurate to +/- 2% of full range.
 3. One gauge shall be provided for each type of filter in filter bank.

4. Gauges shall be recessed into the cabinet casing with a weather cover.

2.09 FINISH

A. Factory Applied Finish for Steel and Galvanized-Steel Casings:

1. Standard Two-coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, ASTM 2000-hour enamel finish, consisting of prime coat and thermosetting topcoat.
2. Casing Coating: Epoxy, Phenolic, Hot-dip galvanized, or Powder-baked enamel.

2.010 ALUMINUM AIRFOIL DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 5 percent of air quantity at 2000 fpm face velocity through damper and 3" wg (1000 Pa) pressure differential.
- B. Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades shall be of a single unit airfoil design 6" wide.
- C. Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames shall be 2" x 4" x 5/8" on the linkage side, 1" x 4" x 1" on the other 3 sides.
- D. Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into the blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into the frame to prevent the outer bearing from rotating.
- E. The bearing shall be designed so there are no metal-to-metal or metal-to-bearing riding surfaces. The interconnecting linkage shall have a separate Celcon bearing to eliminate friction inside the linkage.
- F. Blade linkage hardware shall be installed in a frame outside the airstream. All hardware shall be of non-corrosive, reinforced cadmium plated steel.
- G. Multiple damper motors are to be used rather than jack shaft assemblies.
- H. Dampers shall be Ruskin #CD50, T.A. Morrison #1000, or equivalent.

2.011 VARIABLE FREQUENCY DRIVES

- A. Both supply and return fans are to be powered by drives complete with bypass starter section. See Section 230902 for additional requirements.

2.012 FLOW MEASURING PROVISIONS

A. Air flow measurement - General

1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.

4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
- B. Supply and/or Return Fan Measurement:
1. Measurement device to be mounted in either the fan inlet or the AHU duct opening.
 - a. Fan inlet air measuring devices shall not obstruct the inlet cone to the fan, nor add any pressure losses or sound level increases to the fan performance.
 - b. Air measuring devices mounted in the AHU opening to be mounted upstream of the damper and spaced a minimum of 6" from the damper (if damper).
- C. Outside Air Flow Measurement
1. Air measuring devices to be mounted in the AHU opening upstream of the damper and spaced a minimum of 6" from the damper.
 - a. If the outside air intake dampers are sized for 100% fresh air capability configure the dampers to enable separate control and measurement of the minimum outside air required for the project area served by the AHU.
 - b. If the AHU is installed on the interior with ducted fresh air, install the measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow and temperature.
 - c. If the AHU is an outdoor mounted unit, the minimum outside airflow measurement station is to be factory mounted on the exterior side of the outside air intake in a protective weatherhood.
- D. Sensor Performance:
1. The ATMD shall be capable of measuring airflow rates over the full calibrated range of 0 to 5,000 FPM (25.4 m/s) between -20°F to 160°F (-28.9°C to 71°C).
 2. Each sensing node shall have an airflow accuracy of $\pm 2\%$ of reading throughout the entire calibrated operating range.
 3. Each sensing node shall have a temperature accuracy of $\pm 0.14^\circ\text{F}$ (0.08°C) over the entire operating temperature range of -20°F to 160°F (-28.9°C to 71°C).
 4. Fan Airflow Installation:
 - a. Installed airflow accuracy: $\pm 3\%$ to 10% of reading with $\pm 0.25\%$ repeatability.
 - b. Sensor probe performance: $\pm 2\%$ of reading, 0-5000 fpm, 0.15°F temperature accuracy \pm .
 5. Outside Air Installation:
 - a. Installed airflow accuracy: $\pm 2\%$ of reading with $\pm 0.25\%$ repeatability.
 - b. Sensor probe performance: $\pm 2\%$ of reading, 0-5000 fpm, 0.15°F temperature accuracy \pm .
- E. Transmitter:
1. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC, or BACnet digital compatible. Coordinate signal output with controls installer.
 2. Transmitter to include an airflow gauge to provide direct readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.

3. Device to provide switch selectable Modbus or Johnson N2 outputs. Device to be UL listed.
4. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown- outs.
5. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
6. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
7. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
8. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-28.8°C to 48.8°C).
9. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
10. The Sensors shall be calibrated to NIST traceable standards.

- F. Airflow measuring station shall be manufactured by Ebtron, KURZ, Fluid Components and Sierra Instruments are acceptable with temperature readout and UL listing.

2.013 ELECTRICAL

- A. Each fan motor shall be wired to its respective VFD provided by fan manufacturer integral to unit. See Section 230902 and 2.1, G above for requirements.
- B. All wiring shall be 6600 volt rated type XLPE, RW90 stranded copper, enclosed in conduit run internal to the unit. All junction boxes shall be CSA approved. Three phase loads to be color coded for phase matching.
- C. All unit VFD's shall be wired to a surface or recessed mounted vestibule electrical panel for a single point three phase power connection provided by Division 26. Control panel shall be NEMA Type 3R enclosure with a single hinged access door. The control panel shall include:
1. Non-fused main disconnect switch, lockable in the off position
 2. Dual element fuses
 3. Distribution block
- D. All wiring shall be numbered, and all remote connection terminals and components in the control panel shall be identified by tag suitable attached. Wiring diagram shall be provided for each unit showing all components, wire number and remote connection terminals.
- E. Electrical wiring for lighting and power supply to fan motors shall be run in separate conduits internal to the unit. No external conduit runs are permitted. If the unit requires section splits, junction boxes shall be furnished at each section to allow the electrical contractor to make final connections in the field. Wiring to be clearly labeled at junction points to facilitate reconnection. Air handler manufacturer shall allow a minimum 1.5" clearance above the entire width of each interior bulk headers (coils, filters, fan blank-off, etc.) for field-wiring of any 110v or 24v runs internally to the unit as required by the controls contractor and reduce the number penetrations of the exterior panels.
- F. All electrical wiring and components shall be installed to conform to NEC and UL listing requirements. Provide a UL or ETL listing and label for the entire air handler.

2.014 LIGHTS

- A. Provide vapor-proof marine grade lights with protective metal cage, sealed glass enclosure and 150-watt compact florescent light for each section containing an access door and for unit vestibule. Duplex receptacles shall be installed at the light switch at each fan section and unit vestibule.
- B. A switch with an indicator light shall be installed on the unit controlling both lights and receptacles. Electrical power shall be 120V/1/60 and wired by fan manufacturer to a junction box in the unit vestibule for a single point one phase connection by Division 26.

2.015 AIR-TO-AIR HEAT RECOVERY

- A. The air-to-air plate exchanger shall transfer heat between outgoing and incoming air streams in cross flow arrangement. The sensible plate exchanger shall bear the AHRI Certified Product Seal and rated per AHRI Standard 1060 testing procedures.
- B. The exchanger plates shall be 99.9% per aluminum. Plates made from aluminum alloy, plastic, steel or other materials are not acceptable.
- C. The plates shall be die formed with the patented positive/negative dimple stamping that provides the Hoval Series exclusive plates profile and discontinuous channel design. Plate profile of the laminar flow design type are unacceptable.
- D. Aluminum plate thickness shall be 0.005" (0.127 mm) for the best possible effectiveness. Thicker aluminum plates shall not be acceptable.
- E. The connecting plate edges shall be multiple folded. The double fold shall provide a six fold material thickness on the leading and trailing edges of the plate exchanger and provide protection from the cutting edge of the exchanger plates within the double fold. Construction methods that use a single fold or glue at the leading and trailing edges of the exchanger are not acceptable.
- F. The air-to-air plate exchanger core shall be assembled into a strong self-supporting frame made of aluminum corner extrusions and 20-gauge galvanized steel end plates.
- G. The aluminum corner extrusions shall be hollow to accept mounting screws and shall provide a 45 degree corner support angle.
- H. The Hoval "V" Series construction: the air-to-air plate exchanger package with synthetic resin sealed corners shall be resistant to temperatures up to 194°F (90°C).
- I. The Hoval "G" Series construction option the air-to-air plate exchanger plates shall have an epoxy coated, providing protection for installation in corrosive environment. The heat exchanger package with synthetic resin sealed corners is to be resistant to temperatures up to 194°F (90°C).
- J. The air-to-air exchanger shall withstand without significant change in its performances and pressure drops, a pressure differential of at least 6" wg. It shall withstand a pressure differential at 10" wg without permanent deformation.

2.016 HUMIDIFIERS

- A. Steam Grid Humidifier:

1. Manifold:
 - a. ASTM A666, Type 304 stainless steel.
 - b. Steam jacketed.
 - c. Insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket.
 - d. Manifold shall extend the full width of unit with mounting brackets at ends.
2. Steam Separator: ASTM A666, Type 304 stainless steel, with separate humidifier control valve.
3. Humidifier Control Valve: Actuator: Electric modulating with spring return.
4. Steam Trap: Inverted-bucket type, sized for a minimum of three times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.
5. Aquastat: For separate mounting on steam condensate, return piping to prevent cold operation of humidifier.
6. Strainer: In-line type.
7. Airflow Switch: To prevent humidifier operation in the absence of airflow.

B. Wet Glass Cell Washer Section:

1. 3-inch- (75-mm-) deep cells with random packed, glass-fiber media in stainless-steel frames.
2. Access Door: Watertight with brass fittings, wire glass window, and locking handles.
3. Spray Tree Assembly: Stainless-steel nozzles and stainless-steel piping.
4. Eliminator: Stainless-steel plates.
5. Tank:
 - a. Welded stainless steel, with interior and exterior surfaces blasted and painted with zinc-chromate paint.
 - b. Copper suction screen.
 - c. Drain, overflow, and suction connections.
 - d. Makeup connection with brass float valve, and with quick-fill connection.
6. Insulate exterior with duct insulation and mount on 2-inch (50-mm) thick, rigid insulation board.

C. Evaporative Humidifier Section:

1. Access Door: Watertight with brass fittings, wire glass window, and locking handles.
2. Spray Tree Assembly: Brass nozzles and galvanized piping.
3. Tank:
 - a. Welded steel tank with interior and exterior surfaces blasted and painted with zinc-chromate paint.
 - b. Copper suction screen, drain, overflow, and suction connections.
 - c. Makeup connection with brass float valve, and with quick-fill connection.
4. Insulation: Insulate with duct insulation on exterior and mount on 2-inch (50-mm) thick, rigid insulation board.

2.017 AIR-TO-AIR ENERGY RECOVERY

A. Heat Wheels:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Airxchange.
 - b. American Energy Exchange, Inc.

- c. Loren Cook Company.
 - d. SEMCO Incorporated.
 - e. Trane; American Standard Inc.
 - f. Heatex
2. Casing:
 - a. Steel, with manufacturer's standard paint coating.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
 3. Rotor: Aluminum, segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating. Construct media for passing maximum 500, 800 or 1200-micrometer solids.
 4. Rotor: Glass-fiber Polymer segmented wheel, strengthened with radial spokes impregnated with non-migrating, water-selective, molecular-sieve desiccant coating. Construct media for passing maximum 800 or 1200-micrometer solids.
 5. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller, and self-adjusting multilink belt around outside of rotor.
 6. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Retain one of first three subparagraphs below.
 - c. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
 - d. Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
 - e. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain [exhaust temperature above freezing and] air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 - f. Pilot-Light Indicator: Display rotor rotation and speed.
 - g. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- B. Fixed-Plate Sensible Heat Exchangers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. American Energy Exchange, Inc.
 - b. Des Champs Technologies.
 - c. Exothermics Inc.; a brand of Eclipse, Inc.
 - d. Nutech Brands Inc.
 - e. RenewAire LLC.
 - f. Heatex.
 3. Casing: [Aluminum] [Galvanized steel] [Enameled steel, with galvanized-steel liner] [Enameled steel].
 4. Plates: Evenly spaced and sealed and arranged for counter airflow.

5. Plate Material: [Embossed aluminum] [Stainless steel] [Polypropylene copolymer (high-density plastic)].
 - a. Coatings are available for aluminum plates in corrosive atmospheres.
 - b. Plate Coating: [Epoxy] [Air-dried phenolic].
6. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
7. Water wash and detergent injection are available optional features.
8. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock[, with detergent injection].
9. Heat-Exchanger Prefilters: [1 inch (25 mm) thick, disposable] [2 inches (50 mm) thick, disposable] [Medium efficiency] [Electrostatic].

C. Fixed-Plate Enthalpy Heat Exchangers:

1. Heat Exchanger Performance Requirements
 - a. The enthalpy plate exchanger shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.
 - b. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.
 - c. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.
 - d. The ERV core shall achieve a minimum of 50 % total energy recovery effectiveness tested at rated flows in heating conditions to AHRI 1060-2018 standards.
 - e. The ERV Core shall have a maximum pressure drop of 0.8" wg. as tested at the rated flow to AHRI 1060-2018.
 - f. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.
 - g. The ERV core shall have a 0% Exhaust Air Transport Ratio as tested to AHRI 1060-2018 (EATR) to prevent cross-over of gases, contaminants or odors.
 - h. The ERV core shall inhibit mold and bacteria growth as tested to Standard AATCC 30 with 100% surface inhibition on the Aspergillus mold test and 100% surface inhibition the Kirby Bauer Staphylococcus bacteria test.
 - i. The ERV core must be able to tolerate freezing temperatures of -30°C and not have an increase in EATR or decrease in performance after being frozen.
 - j. The ERV core must be able to tolerate high temperatures of +60°C and not have an increase in EATR or decrease in performance at these elevated temperatures.
 - k. The ERV core must be water washable to remove dust and contaminants.
 - l. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50
2. Frame and Inspection Requirements
 - a. The ERV shall have a frame consisting of 5052 series aluminum end plates and aluminum alloy 6063 extruded side rails.
 - b. Provide removable panels for inspection and cleaning of the heat transfer surface on the dirty air side without dismantling the system.
3. Heat-Exchanger Prefilters: 2 inches (50 mm) thick, disposable Medium efficiency
4. Manufacturer: dPoint Technology.

2.018 ELECTRICAL HEATING COIL

- A. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Refer to schedule on drawings for voltage, capacity and staging.
- B. Coil Assembly: Comply with UL 1995.
- C. Heating Elements: Type A coiled resistance wire of 80 percent nickel and 20 percent chromium.
 - 1. Open Coil: Coils shall be machine crimped into stainless steel terminals extending at least 1" into the air stream and all terminal hardware shall be stainless steel. Coils shall be supported by ceramic bushings staked into supporting brackets. Maximum brackets spacing not to exceed 4-1/2" apart.
 - 2. Finned Tubular: Heating elements shall be finned tubular Type A resistance wire, precisely centered in a stainless steel tube and filled with granular magnesium oxide. The entire assembly is to be compacted to maximize both the heat transfer and dielectric properties of the magnesium oxide. After compacting the tube must be a minimum of 0.475" O.D. to provide sufficient insulation for operation up to 600 volts. A corrugated stainless steel fin is to be wrapped around the tube to increase its heat transfer surface. Both straight and U-bent elements are to be furnished with mounting flanges, making them individually removable from the terminal box. Element support brackets are not to be spaced more than 36" apart.
- D. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
- E. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- F. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) thick for flanged mounting.
- G. Control Panel: Unit mounted terminal box shall be NEMA-1, or NEMA-4 type construction when mounted exposed to weather, with disconnecting means and overcurrent protection. Include the following control features:
 - 1. Magnetic contactor.
 - 2. Mercury contactor.
 - 3. Toggle switches; one per step.
 - 4. Step controller.
 - 5. Time-delay relay.
 - 6. Pilot lights; one per step.
 - 7. Airflow proving switch.

H. Manufacturers: Indeeco, Chromalox, Brasch, Dunham-Bush, Trane.

2.019 AIR LEAKAGE TESTING

- A. Before shipment the unit manufacturer shall factory pressure test (positive pressure) each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure. Testing shall be done on one unit of each type.
- B. The test shall be conducted in accordance with SMACNA duct construction manual. A calibrated orifice shall be used to measure leakage airflow.

2.020 SOUND POWER LEVELS

- A. Air handling unit sound power levels shall be submitted for review. Sound power data shall be given at the supply connections, return connections, outside air connections, and exhaust air connections in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from testing on the identical fans as used in the units. Data extrapolated from different fans is not acceptable.
- B. Attenuation assumed for cabinet configuration, type of insulation, opening location and sizes shall be verified through actual test measurements. Sound power data is tested at the factory by an acoustical engineer in complete accordance with ARI 260-2001, "Sound Rating of Ducted Air Moving and Conditioning Equipment". These test reports will be submitted to the Architect before units ship from the factory.
- C. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

Table 1: Maximum Allowable Sound Power Values per ARI 260 in dB re 1 picowatt

Unit ID	Source	Test	63	125	250	500	1K	2K	4K	8K
		ARI 260								
		ARI 260								
		ARI 260								
		ARI 260								

- D. Fans to be tested in complete accordance with AMCA 300-1996, "Reverberant Room Method for Sound Testing of Fans", in a testing laboratory certified by AMCA to perform the test for both 210 performance and 300 sound. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

Table 2: Casing Radiated Maximum Allowable Sound Power Values per AMCA 300 in dB re 1 picowatt

Fan ID	Fan Type	63	125	250	500	1K	2K	4K	8K

PART 3 EXECUTION

3.01 EXAMINATION

- A. Install in accordance with manufacturer's instructions.
- B. Examine site to verify if site is ready to receive work. Provide a layout drawing of air handler and fan locations to electrical installer.

- C. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Air Handler Mounting:

1. Base Mounted: Install air-handling units on equipment base as described and specified elsewhere
 - a. Concrete: Comply with requirements for equipment bases and foundations specified in Division 03.
 - b. If return fans are configured to drawing inlet air from a raised curb, curb access must be provided for field installation and service of measuring devices and smoke detectors.
2. Suspended Mounting: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
3. Vibration Isolators: Comply with requirements of 230548 Vibration Isolation.
4. Seismic Restraints: Comply with requirements for 230549 Seismic Restraint.
5. Arrange installation of units to provide access space around air-handling units for service and maintenance.
6. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
7. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to air-handling unit to allow service and maintenance.
- D. Mount interior unit on vibration isolation springs.
- E. Mount rooftop unit on:
 1. Seismically restrained spring vibration isolation curb. Install with top surface of roof mounting frame level.
 2. Or, factory built roof mounting frame where vibration will not be perceptible to occupants. Install with top surface of roof mounting frame level.
- F. Install 3" flexible duct connection at inlets and outlets of units.

- G. Connect piping with flexible connectors.
 - H. Connect condensate drain pans using ASTM B88, Type M or Type L copper tubing as shown on plumbing drawings and specifications. Extend to nearest roof receptor, floor sink, or floor drain. Construct deep P-trap at connection to drain pan and install cleanouts at changes in direction.
 - 1. Install manufacturer provided condensate “air-trap” where provided with each air handling unit. Install trap per manufacturer’s instructions and install condensate piping as required by local code.
 - I. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 HVAC Piping, Valves and Specialties. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
 - J. Steam and Steam Condensate Piping: Comply with applicable requirements in Section 232213 Steam and Condensate Piping, Valves and Specialties. Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.
 - K. Refrigerant Piping: Comply with applicable requirements in Section 232300 Refrigerant Piping Systems. Install shutoff valve and union or flange at each supply and return connection.
 - L. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 233113 Air Distribution.
 - M. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233113 Air Distribution.
 - N. Control installers shall install all wiring associated with control signals into the air handlers.
 - O. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
 - P. Airflow measuring arrays installed in fan inlet volutes must be designed to withstand velocities encountered in this location. Mounting system is to be warranted against failure and consequent fan damage.
- 3.04 START-UP SERVICES
- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - B. Tests and Inspections:
 - 1. Leak Test: After installation, fill coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
 - 5. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.

6. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
 7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.05 STARTUP SERVICE
- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that zone dampers fully open and close for each zone.
 7. Verify that face-and-bypass dampers provide full face flow.
 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace sheaves, fan pulleys and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. ADJUSTING
1. Adjust damper linkages for proper damper operation.
 2. Comply with requirements in Section 230593 Testing, Adjusting and Balancing.
- D. CLEANING
1. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

E. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

3.06 AIR HANDLING UNIT CONFORMANCE

- A. Manufacturer representative shall complete the following table and provide a copy with each submittal package to assure conformance to specifications:
- B. Air Handler COMPLIANCE Checklist:

AIR HANDLER PERFORMANCE	
Manufacturer	
Dimensions (LxWxH inches)	
Operating Weight (LBS)	
Total Air Flow (CFM)	
System Supply Air Static Pressures (in. wg.)	
External Supply Ductwork	
Discharge Loss	
Cooling Coil	
Clean Filters	
Dirty Filter Allowance	
Damper/Louver/Fitting Loss	
Total Supply Fan Static	
Systems Return Air Static Pressures (in. wg.)	
External Return Air Static Pressure	
Entrance Loss	
Internal Louver/Damper/Fitting Loss	
Total Return Fan Static	
SUPPLY FAN PERFORMANCE	
Supply Fan BHP	
Supply Fan HP	
Supply Fan RPM	
Supply Fan Efficiency	
Direct Drive Plenum Fans	Yes or No
Fan Arrangement	
Pressure Class	
Aluminum Construction	Yes or No
Bearings (L 10/200000 hours)	Yes or No
Fans selected at rated motor RPM	Yes
RETURN FAN PERFORMANCE	
Return Fan BHP	

Return Fan HP	
Return Fan RPM	
Return Fan Efficiency	
Direct Drive Plenum Fans	Yes or No
Fan Arrangement	
Pressure Class	
Aluminum Construction	Yes or No
Bearings (L 10/200000 hours)	Yes or No
Fans selected at rated motor RPM	Yes
COIL PERFORMANCE	
Total Capacity (MBH)	
Sensible Capacity (MBH)	
Face Velocity (FPM)	
GPM	
Water Pressure Drop (ft. H ₂ O)	
Coils/Fins per Inch/Rows	
Tube Size (inches)	
Tube thickness (inches)	
Tube return bend thickness (inches)	
Coils have 16 ga 304 SS	Yes or No
Drain pans are 304 SS	Yes or No
Coil blank offs are 304 SS	Yes or No
CABINET CONSTRUCTION	
Structural Steel Channel base	Yes or No
Tubular steel base	Yes or No
Can vary base height	Yes or No
Structural steel channel cross support	Yes or No
Formed channel cross support	Yes or No
Cross support max spacing	
Thermal break at joints	Yes or No
Outer steel (gauge)	
Solid inner steel (gauge)	
Insulation (wall/floor thickness) (inches)	

Standing seam construction	Yes or No
Welded frame construction	Yes or No
Bolted construction	Yes or No
Sheet metal screw construction	Yes or No
Standing seam roof with seam cleats	Yes or No
Roof attachment external to unit casing	Yes or No
Outdoor-pitched roof	Yes or No
Access door locations as required	Yes or No
Double seals on doors	Yes or No
Latches per door (number)	
Adjustable door hinges	Yes or No
Adjustable door latches	Yes or No
Access doors open against static pressure	Yes or No
Door safety "Kill" switches	Yes or No
Polyurethane paint	Yes or No
Vents and drains extended to outside cabinet	Yes or No
Cabinet Sounds data for inlet & outlet	
Supply connection at 125 & 1000 hz (db)	
Return connection at 125 & 1000 hz (db)	
Economizer has min/max dampers	Yes or No
Dampers sizing (maximum fpm)	
Outside air louver sizing (maximum fpm)	
Exhaust air louver sizing (maximum fpm)	
Exterior hoods	Yes or No
ADDITIONAL UNIT FEATURES	
Marine lights with GFI	Yes or No
Fan screen enclosures	Yes or No
Min OSA air flow station	Yes or No
Airflow stations on each fan	Yes or No
Motor removal rails	Yes or No
Bellmouth outlet	Yes or No
Roof curb	Yes or No
TEFC premium efficiency motors	Yes or No

Shaft grounding factory mounted on motors	Yes or No
Variable Frequency Drive (VFD) manufacturer	
VFD's are factory mounted & wired (UL508)	Yes or No
Data sheets for VFD's	Yes or No
Filters are size and type specified	Yes or No
Filter frames are face load type 8	Yes or No
Two filter gages (one per filter bank)	Yes or No
Weather covers for filter gages	Yes or No
Data sheets for filters	Yes or No
Data sheets for air flow stations	Yes or No
PROVIDE DETAILS	
Base/floor construction	Yes or No
Casing/cabinet construction	Yes or No
Access doors	Yes or No
Door hinges and latches	Yes or No
Fan curves	Yes or No
Pressure losses (including internal/external loss)	Yes or No
Sound data for inlet/outlet	Yes or No
Electrical wiring diagram	Yes or No
Vibration isolation detail	Yes or No
Coil construction	Yes or No
VFD mounting details	Yes or No
MANUFACTURER CAPABILITIES	
Fan Wheel Manufacturer	
Coil Manufacturer	
Dampers Manufacturer	
Louver Manufacturer	
Isolator Manufacturer	
Have a certified UL508 electrical shop	Yes or No
ARI certified for coils	Yes or No
Coil Testing Capabilities	Yes or No

AMCA certified for blowers	Yes or No
UL-508	Yes or No
AMCA 210 accredited lab	Yes or No
AMCA 300 accredited lab	Yes or No
Ability to perform leak tests	Yes or No
UL-508 compliance	Yes or No
Unit ETL or UL listing	Yes or No

END OF SECTION

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SECTION 23 73 13
MODULAR AIR HANDLERS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SUMMARY

- 1. Section Includes:
 - a. Variable-air-volume, single-zone air-handling units.
 - b. Variable-air-volume, dual-duct air-handling units.
 - c. Constant-air-volume, single-zone air-handling units.
 - d. Constant-air-volume, multizone air-handling units.
 - e. Constant-air-volume, dual-duct air-handling units.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods
- B. Section 23 05 93 - Testing, Adjusting and Balancing
- C. Section 23 09 02 - Variable Frequency Drives (VFD)
- D. Section 23 31 13 - Air Distribution
- E. Section 23 41 00 - Air Filtration
- F. Division 26: Electrical

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of $L/100$, minimum, where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. **Certifications:** Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
- C. **Codes and Standards:** Provide air handling units conforming to the requirements of the latest addition of the following:
 1. **Air Movement and Control Association (AMCA):**
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans [Unit shall bear AMCA Certified Rating Seal]
 - c. 300 - Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
 - d. 320 - Laboratory Methods of Sound Testing of Fans Using Sound Intensity
 - e. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - f. 500 - Test Method for Louvers, Dampers, and Shutters
 2. **American National Standards Institute (ANSI):**
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units
 3. **Air-Conditioning, Heating and Refrigeration Institute (AHRI):**
 - a. 410 - Forced-Circulation Air-Cooling and Air-Heating Coils
 - b. 430 - Central-Station Air-Handling Units
 4. **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):**
 - a. 15 - Safety Code for Mechanical Refrigeration
 5. **National Electrical Manufacturers Association (NEMA):** Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 6. **National Fire Protection Association (NFPA):** Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.
9. Units shall be listed and labeled by either UL or ETL for air handler construction.

1.06 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 1. The proposed substitution does not affect dimensions shown on drawings.
 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.07 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing
 1. Dimensions and weights
 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 3. Fan including:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - e. Fan assembly vibration and balance test report.
 4. Certified coil-performance ratings with system operating conditions indicated.
 5. Retain both subparagraphs below if items are furnished as parts of air-handling units.
 6. Dampers, including housings, linkages, and operators.
 7. Filters with performance characteristics.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.

- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.08 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.11 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Energy Labs, Nortek Air Solutions (Governair, Huntair, Venmar, Temtrol, Mammoth), York Solution Custom, or Haakon Industries. By listing various manufacturers does imply that their standard construction is approved or that they are equal. All manufacturers must meet, or exceed, minimum requirements of these specifications and all other standard or optional features provided by the scheduled basis of design air handler.

2.02 GENERAL

- A. Any exceptions to the specifications must be clearly defined in the submittal process. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

- B. Fabricate draw-thru or blow-thru type air handling units suitable for the scheduled air pressure operation as indicated.
- C. Fabricate units with the following features: fan sections as noted; coil section(s); heat recovery sections, mixing section; filter section(s); access section(s); discharge plenum; bell mouth duct connections; variable frequency drives; dampers; lights and vestibules. Fabricate unit in split sections for field assembly if necessary.
- D. Vestibule piping requirements: If shown on plans all piping located within the air handler vestibule is to be supported as specified. Mechanical Contractor to coordinate with air handler supplier to insure that all supports are provided and that adequate structural reinforcement is provided within the air handler to accommodate the operational weight of the pipe supported. The Mechanical Contractor is to provide the air handler manufacturer with an approved shop drawing indicating the location and weight of all equipment and the location of all piping and pipe penetrations located in the air handler vestibule prior to the design of the air handler by the manufacturer.
- E. Fans shall be selected for variable volume operation. The scheduled fan arrangement and unit configuration is the basis of selection. Alternate configurations which are equal or smaller in size and weight, energy and acoustic performance will be considered. Include information indicating pertinent differences, either positive or negative, to base design indicated on documents. Unit component face velocity to remain as designed to conserve motor horsepower. The mechanical contractor and supplier shall bear all costs for redesign of mechanical, plumbing, electrical, structural, architectural and controls that may be associated with the revised configuration. Provide analysis of unit power consumption for code compliance.
- F. Factory fabricate and test air handling units of sizes, capacities, and configuration as indicated and specified.
- G. All major components used to assemble air handling units with the exception of electrical devices, drives, bearings and controls shall be manufactured by the air handler manufacturer.
- H. Motors shall be inverter duty NEMA MG-1 premium efficiency TEFC type. All wiring shall be routed to a single external junction box for each fan section.
- I. Filter section shall include space for face load or side access slide-in filters with 2" or 4" pre-filters and 22" bag type final filters with an average efficiency of 85% per ASHRAE Standard 52-76 test.
- J. Provide measurement arrays as described below.

2.03 UNIT CASING

- A. Walls and roofs shall be constructed of 16-gauge, G90 galvanized steel 4" thick panels. The inner wall shall be a minimum of 22-gauge, solid galvanized steel in all sections except fan inlet and fan section which may be perforated metal. The wall panels shall be insulated with 4", 3.0 lbs/cu. ft rigid neoprene coated insulation. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" x 3/8" tape sealer. Wall seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.
- B. All panels shall be joined using bolts rather than sheet metal screws.

- C. All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable.
- D. Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, additional internal reinforcing shall be added.
- E. Provide duct bellmouth fittings where dimensions allow. Provide walk able grates over all duct floor penetrations, maximum pressure loss not to exceed 0.10-inches WC.

F. Acoustical Performance:

- 1. The housing shall have been tested for acoustical performance by an independent laboratory that is accredited.
- 2. Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.

a. Sound Transmission Loss DB ASTM E-90 & E413-73.

	1	2	3	4	5	6	7	8	
4" Walls	20	20	28	41	51	56	55	57	STC=40

b. Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83.

c. Sound Absorption ASTM C423-84A & E795-83.

	1	2	3	4	5	6	7	8	
4" Walls	.40	.65	1.38	1.28	1.09	1.05	1.02	1.02	NRC=1.20

d. Submit lab report for approval.

2.04 BASE CONSTRUCTION

- A. Units shall be constructed from structural steel C-channel around the perimeter of the unit with intermediate channel, angle or tube supports.
 - 1. Channel bases shall be sized as a function of air handling length as follows:

<u>AHU LENGTH</u>	<u>MINIMUM CHANNEL SIZE</u>	
UP to 10	4" x 1-5/8"	(5.4 lbs/Lin.Ft.)
11' to 20'	6" x 2"	(8.2 lbs/Lin.Ft.)
21' to 30'	8" x 2-1/2"	(11.5 lbs/Lin.Ft.)
41' to 50'	12" x 3"	(20.7 lbs/Lin.Ft.)

- B. Floor shall be flat, reinforced from below, with all seams continuously welded or floor shall be 0.12" checker plate installed on the base. Drive screw attachment and caulking are not acceptable. The base shall be provided with lifting lugs, a minimum four per unit section. The base shall be insulated tight to the floor with 4", 3.0 lbs/cu. ft fiberglass insulation. The insulation is to be protected with 22-gauge solid galvanized steel liner if the unit floor is exposed in a suspended application. Floors that "oil can" are not acceptable.
- C. Floor insulation shall be installed beneath the floor panels in the same manner as the wall and ceiling insulation.
- D. Condensate Drain Pans:
1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 2. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 3. Depth: A minimum of 2 inches (50 mm) deep.
 4. Integral part of floor plating
 5. Single-wall 16-gauge, 304 stainless-steel sheet.
 6. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on pan. Outlet diameter shall meet minimum sizing requirement of applicable mechanical code.
 7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
 8. The manufacturer shall provide a 1.5" perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.
 9. The manufacturer shall provide auxiliary drains in mixing and OSA intake sections.
 10. All drain connections on floor mounted air handling units shall terminate at the side of the unit.
- E. Maximum base deflection shall be 1/4" on 20-foot unsupported span.
- F. Maintenance Rails: Provide overhead lifting rails in sections where motor service will be required.

2.05 INSPECTION AND ACCESS PANELS AND ACCESS DOORS

- A. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
- B. Inspection and Access Panels:
 - 1. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - 2. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
- C. Access Doors:
 - 1. Hinges: A minimum of two ball-bearing hinges and two roller cam-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - 2. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - 4. Size: The minimum door clearance shall not be less than 19"x 70" (where unit height permits) and shall be large enough to allow the largest assembled internal compound to be removed through the doorway. Internal components must have a door of minimum width to remove the assembled components. Vestibule doors to the exterior shall be 42"x70" (where unit height permits).
- D. Locations and Applications:
 - 1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.
 - 2. Fan Section: Doors and inspection and access panels.
 - 3. Access Section: Doors.
 - 4. Coil Section: Inspection and access panel.
 - 5. Damper Section: Doors.
 - 6. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - 7. Mixing Section: Doors.
 - 8. Humidifier Section: Doors.

2.06 FAN, DRIVE, AND MOTOR SECTION

- A. All fans shall be tested in accordance with AMCA Standard 210-70 Test Code for Air Moving Devices. Fans shall bear the AMCA sticker for both air and sound performance.
- B. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil. Hollow shafts are unacceptable.

- b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range. The critical speed will be based on the top of the speed range for the fans' AMCA class. The lateral static deflection shall not exceed 0.003" per foot of the length of the shaft.
 2. Fan assembly shall be balanced per ISO standard G6.3 with a copy of the balance test data for this project with deflection and critical speed of the shaft and wheel submitted to the engineer
- C. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Horizontal-Flanged, Split Housing: Bolted construction.
 3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
 4. Flexible Connector: Factory fabricated with a fabric strip [3-1/2 inches (89 mm)] [5-3/4 inches (146 mm)] wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet or 0.032-inch- (0.8-mm-) thick aluminum sheets; select metal compatible with casing.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq.m).
 - 2) Fabric Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3) Fabric Service Temperature: Minus 40 to plus 200°F (Minus 40 to plus 93°C).
- D. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
 1. Arrangement #4 direct drive fans or AMCA Arrangement #1 either horizontal or vertical as shown on plans and drawings. There shall be no obstructions (i.e., bearings or bearing supports, etc.) at the inlet of the fan. Fan wheel shall be aluminum with aluminum extruded airfoil blades. The fan inlet on plenum fans shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
 2. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.
- E. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws. Aluminum wheel.
- F. Axial Fans: Fan wheel and housing, straightening-vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
- G. Housings: Steel, galvanized steel, or aluminum.
 1. Inlet and Outlet Connections: Flanges.

2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
- H. Fan Array Installation:
1. Provide individual fan back draft dampers and acoustical treatment.
 2. Each fan and motor shall be mounted on an all welded, structural steel, prime coated, internal isolation base with springs selected to provide 99% isolation efficiency with minimum 1" deflection. The inlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection. Provide unit mounted red LED indicator lights to monitor status of all fan array fans, one light per fan. LED to light up indicating loss of respective fan operation. Label lights "FAN FAILURE LIGHTS".
- I. Fan Shaft Bearings:
1. Pre-lubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L10 rated life of 200,000 hours according to ABMA 9. Bearings are to be mounted on the fan structural bracing. Provide extended bearing lubrication lines and zerk fittings to assure accessibility of all lubrication points without disassembly of unit access.
- J. Internal Vibration Isolation and Seismic Control:
1. Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection as stated on the drawings.
 2. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
 3. Fan Assembly Testing:
 - a. Following assembly, the fan balance shall be tested using an electronic balance analyzer with tunable filter and stroboscope.
 - b. Direct drive fan wheels shall be factory dynamically balanced and shall meet or exceed guidelines in AMCA 204-96 for Balance Quality and Vibration Levels for Fan Application Category BV-5. Following fan assembly, the complete spring isolated fan assembly shall be tested using an electronic balance analyzer with tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 Axial). The maximum allowable velocity shall not exceed 0.125 inches per second peak amplitude (filter in) on any of 5 readings and shall not exceed .5 mils @ 1170 rpm.
 - c. A copy of the Vibration test report (Vibration Nomograph) shall be provided with the Operation and Maintenance Manual upon request. The fan assembly shall also be vibration tested at design RPM with the spring isolators at the specified deflection, with the tunable filter utilized and frequencies from 500 cpm to 50,000 cpm shall be scanned to detect misalignment, bearing defects, mechanical looseness or foundation weakness. A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted for review.
- K. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
1. Enclosure Type: Totally enclosed, fan cooled.
 2. NEMA Premium (TM) efficient motors as defined in NEMA MG1.

3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Mount unit-mounted disconnect switches on exterior of unit.

2.07 COILS

- A. Coils shall be designed with counter flow design.
- B. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service and can be removed from the unit through the side. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410-81.
- C. Coils shall be fully enclosed within casing and mounted on primed and painted angle iron racks manufactured to allow coils to slide out individually. Cooling coil racks shall be primed with zinc rich chromate primer. Racks to be designed to allow coil removal from the face of the coil rack. All coils to be removable from either side of the unit by easily removable end panels. End panels that open to coil header and return bend section shall be installed with drive screws and nut-serts to allow access to header and return bend sections for coil inspection without disruption to unit air seal. Individual end panels to be supplied for each coil on the supply and return side of the cabinet to allow single coil piping breakdown for coil removal.
- D. Coil penetrations through cabinet shall be grommeted, sealed airtight by a double escutcheon plate on the exterior of the casing. The escutcheon plate shall have a rolled collar around the pipe opening to protect the pipe and be equipped with an "O" ring rubber gasket between the collar and the pipe to prevent chaffing and provide an air tight seal around the opening. All supply and return connections shall be plainly and permanently marked
- E. Both ends of the coil to be sealed off from the main air stream by full height blank-offs on both the entering-air and leaving-air sides. Blank-offs to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height and width of the coil casing to reduce condensation.
- F. Drain pans shall be continuously welded type 304 stainless steel. Intermediate drain pans shall be interconnected with 1 in. stainless steel drain lines. Drain pans shall be sloped and fully drainable.
- G. All coils shall be fabricated of 5/8" O.D. seamless copper tubing of 0.020 wall thickness minimum mechanically expanded into aluminum fins of 0.008 minimum thickness. All return bends shall be 0.035 copper minimum. Headers shall be of seamless copper. Supply and return connections on each coil shall be raised/lowered a minimum 6" from the bottom/top of the coil to allow room for piping connection hookup between stacked coils, coils near floors and coils near roofs. Each coil shall be provided with capped vent and drain connections extended to the exterior of the cabinet. All coils shall be fully drained with no trapped tubes. Coil casing to be 304 stainless steel for cooling coils and 16-gauge galvanized for heating coils.
- H. Coils shall be hydrostatically tested at 400 psi, and shall be suitable for working pressures and temperature up to 200 psi and 22°F.

- I. Pipe connections shall be on the same end, and shall be threaded. On units with split coils, extend coil pipe connections from coil header through unit side casing using specified pipe material.
- J. Water coils handling recently mixed air, or direct outside air, shall be fully drainable by removing a single threaded plug for each coil row.
- K. Coils indicated as being cleanable shall have either a cleanout plug for each tube or shall have a gasketed removable header cover.
- L. On cooling coils and heat recovery coils using vertically corrugated fins or spiral wound fins, provide moisture eliminators on the downstream side of cooling coils and heat recovery coils when the face velocity exceeds 550 fpm. On cooling coils and heat recovery coils using horizontally corrugated fins, provide moisture eliminators when the face velocity exceeds 525 fpm. Moisture eliminators shall be 304 stainless steel, 3-break type draining directly into the cooling coil drain.
- M. Coils for direct expansion refrigerant applications connected to multiple compressors shall be full face intertwined type.
- N. All coils installed in geographical locations where freezing air temperatures will enter the coil provide relief freeze caps on each coil. Freeze cap fittings shall be brazed construction with screw-on, screw-off removable cap. Install on all return bends on both sides of coil, on applicable headers and tube ends as required. Manufacturer: USA Coil & Air Sentry-Guard or equal.

2.08 FILTERS

- A. Provide pre-filters and front loading final filters.
- B. Filter Gauges
 - 1. The manufacturer shall provide a DWYER (0-2 inch, 0-500 Pa) magnehelic gauge.
 - 2. Magnehelic gauges shall be accurate to +/- 2% of full range.
 - 3. One gauge shall be provided for each type of filter in filter bank.
 - 4. Gauges shall be recessed into the cabinet casing with a weather cover.

2.09 FINISH

- A. Factory Applied Finish for Steel and Galvanized-Steel Casings:
 - 1. Standard Two-coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, ASTM 2000-hour enamel finish, consisting of prime coat and thermosetting topcoat.
 - 2. Casing Coating: Epoxy, Phenolic, Hot-dip galvanized, or Powder-baked enamel.

2.10 ALUMINUM AIRFOIL DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 5 percent of air quantity at 2000 fpm face velocity through damper and 3" wg (1000 Pa) pressure differential.
- B. Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades shall be of a single unit airfoil design 6" wide.

- C. Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames shall be 2" x 4" x 5/8" on the linkage side, 1" x 4" x 1" on the other 3 sides.
- D. Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into the blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into the frame to prevent the outer bearing from rotating.
- E. The bearing shall be designed so there are no metal-to-metal or metal-to-bearing riding surfaces. The interconnecting linkage shall have a separate Celcon bearing to eliminate friction inside the linkage.
- F. Blade linkage hardware shall be installed in a frame outside the airstream. All hardware shall be of non-corrosive, reinforced cadmium plated steel.
- G. Multiple damper motors are to be used rather than jack shaft assemblies.
- H. Dampers shall be Ruskin #CD50, T.A. Morrison #1000, or equivalent.

2.11 VARIABLE FREQUENCY DRIVES

- A. Both supply and return fans are to be powered by drives complete with bypass starter section. See Section 23 09 02 for additional requirements.

2.12 FLOW MEASURING PROVISIONS

- A. Air flow measurement - General
 - 1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
 - 2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
 - 3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.
 - 4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
- B. Supply and/or Return Fan Measurement:
 - 1. Measurement device to be mounted in either the fan inlet or the AHU duct opening.
 - a. Fan inlet air measuring devices shall not obstruct the inlet cone to the fan, nor add any pressure losses or sound level increases to the fan performance.
 - b. Air measuring devices mounted in the AHU opening to be mounted upstream of the damper and spaced a minimum of 6" from the damper (if damper).
- C. Outside Air Flow Measurement
 - 1. Air measuring devices to be mounted in the AHU opening upstream of the damper and spaced a minimum of 6" from the damper.
 - a. If the outside air intake dampers are sized for 100% fresh air capability configure the dampers to enable separate control and measurement of the minimum outside air required for the project area served by the AHU.

- b. If the AHU is installed on the interior with ducted fresh air, install the measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow and temperature.
- c. If the AHU is an outdoor mounted unit, the minimum outside airflow measurement station is to be factory mounted on the exterior side of the outside air intake in a protective weatherhood.

D. Sensor Performance:

1. The ATMD shall be capable of measuring airflow rates over the full calibrated range of 0 to 5,000 FPM (25.4 m/s) between -20°F to 160°F (-28.9°C to 71°C).
2. Each sensing node shall have an airflow accuracy of $\pm 2\%$ of reading throughout the entire calibrated operating range.
3. Each sensing node shall have a temperature accuracy of $\pm 0.14^\circ\text{F}$ (0.08°C) over the entire operating temperature range of -20°F to 160°F (-28.9°C to 71°C).
4. Fan Airflow Installation:
 - a. Installed airflow accuracy: $\pm 3\%$ to 10% of reading with $\pm 0.25\%$ repeatability.
 - b. Sensor probe performance: $\pm 2\%$ of reading, 0-5000 fpm, 0.15°F temperature accuracy \pm .
5. Outside Air Installation:
 - a. Installed airflow accuracy: $\pm 2\%$ of reading with $\pm 0.25\%$ repeatability.
 - b. Sensor probe performance: $\pm 2\%$ of reading, 0-5000 fpm, 0.15°F temperature accuracy \pm .

E. Transmitter:

1. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC, or BACnet digital compatible. Coordinate signal output with controls installer.
2. Transmitter to include an airflow gauge to provide direct readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
3. Device to provide switch selectable Modbus or Johnson N2 outputs. Device to be UL listed.
4. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown-outs.
5. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
6. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
7. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
8. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-28.8°C to 48.8°C).

9. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
10. The Sensors shall be calibrated to NIST traceable standards.

- F. Airflow measuring station shall be manufactured by Ebtron, KURZ, Fluid Components and Sierra Instruments are acceptable with temperature readout and UL listing.

2.13 ELECTRICAL

- A. Each fan motor shall be wired to its respective VFD provided by fan manufacturer integral to unit. See Section 230902 and 2.1, G above for requirements.
- B. All wiring shall be 6600 volt rated type XLPE, RW90 stranded copper, enclosed in conduit run internal to the unit. All junction boxes shall be CSA approved. Three phase loads to be color coded for phase matching.
- C. All unit VFD's shall be wired to a surface or recessed mounted vestibule electrical panel for a single point three phase power connection provided by Division 26. Control panel shall be NEMA Type 3R enclosure with a single hinged access door. The control panel shall include:
1. Non-fused main disconnect switch, lockable in the off position
 2. Dual element fuses
 3. Distribution block
- D. All wiring shall be numbered, and all remote connection terminals and components in the control panel shall be identified by tag suitable attached. Wiring diagram shall be provided for each unit showing all components, wire number and remote connection terminals.
- E. Electrical wiring for lighting and power supply to fan motors shall be run in separate conduits internal to the unit. No external conduit runs are permitted. If the unit requires section splits, junction boxes shall be furnished at each section to allow the electrical contractor to make final connections in the field. Wiring to be clearly labeled at junction points to facilitate reconnection. Air handler manufacturer shall allow a minimum 1.5" clearance above the entire width of each interior bulk headers (coils, filters, fan blank-off, etc.) for field-wiring of any 110v or 24v runs internally to the unit as required by the controls contractor and reduce the number penetrations of the exterior panels.
- F. All electrical wiring and components shall be installed to conform to NEC and UL listing requirements. Provide a UL or ETL listing and label for the entire air handler.

2.14 LIGHTS

- A. Provide vapor-proof marine grade lights with protective metal cage, sealed glass enclosure and 150-watt compact florescent light for each section containing an access door and for unit vestibule. Duplex receptacles shall be installed at the light switch at each fan section and unit vestibule.
- B. A switch with an indicator light shall be installed on the unit controlling both lights and receptacles. Electrical power shall be 120V/1/60 and wired by fan manufacturer to a junction box in the unit vestibule for a single point one phase connection by Division 26.

2.15 AIR-TO-AIR HEAT RECOVERY

- A. The air-to-air plate exchanger shall transfer heat between outgoing and incoming air streams in cross flow arrangement. The sensible plate exchanger shall bear the AHRI Certified Product Seal and rated per AHRI Standard 1060 testing procedures.
- B. The exchanger plates shall be 99.9% per aluminum. Plates made from aluminum alloy, plastic, steel or other materials are not acceptable.
- C. The plates shall be die formed with the patented positive/negative dimple stamping that provides the Hoval Series exclusive plates profile and discontinuous channel design. Plate profile of the laminar flow design type are unacceptable.
- D. Aluminum plate thickness shall be 0.005" (0.127 mm) for the best possible effectiveness. Thicker aluminum plates shall not be acceptable.
- E. The connecting plate edges shall be multiple folded. The double fold shall provide a six fold material thickness on the leading and trailing edges of the plate exchanger and provide protection from the cutting edge of the exchanger plates within the double fold. Construction methods that use a single fold or glue at the leading and trailing edges of the exchanger are not acceptable.
- F. The air-to-air plate exchanger core shall be assembled into a strong self-supporting frame made of aluminum corner extrusions and 20-gauge galvanized steel end plates.
- G. The aluminum corner extrusions shall be hollow to accept mounting screws and shall provide a 45 degree corner support angle.
- H. The Hoval "V" Series construction: the air-to-air plate exchanger package with synthetic resin sealed corners shall be resistant to temperatures up to 194°F (90°C).
- I. The Hoval "G" Series construction option the air-to-air plate exchanger plates shall have an epoxy coated, providing protection for installation in corrosive environment. The heat exchanger package with synthetic resin sealed corners is to be resistant to temperatures up to 194°F (90°C).
- J. The air-to-air exchanger shall withstand without significant change in its performances and pressure drops, a pressure differential of at least 6" wg. It shall withstand a pressure differential at 10" wg without permanent deformation.

2.16 HUMIDIFIERS

- A. Steam Grid Humidifier:
 - 1. Manifold:
 - a. ASTM A666, Type 304 stainless steel.
 - b. Steam jacketed.
 - c. Insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket.
 - d. Manifold shall extend the full width of unit with mounting brackets at ends.
 - 2. Steam Separator: ASTM A666, Type 304 stainless steel, with separate humidifier control valve.
 - 3. Humidifier Control Valve: Actuator: Electric modulating with spring return.
 - 4. Steam Trap: Inverted-bucket type, sized for a minimum of three times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.

5. Aquastat: For separate mounting on steam condensate, return piping to prevent cold operation of humidifier.
6. Strainer: In-line type.
7. Airflow Switch: To prevent humidifier operation in the absence of airflow.

B. Wet Glass Cell Washer Section:

1. 3-inch- (75-mm-) deep cells with random packed, glass-fiber media in stainless-steel frames.
2. Access Door: Watertight with brass fittings, wire glass window, and locking handles.
3. Spray Tree Assembly: Stainless-steel nozzles and stainless-steel piping.
4. Eliminator: Stainless-steel plates.
5. Tank:
 - a. Welded stainless steel, with interior and exterior surfaces blasted and painted with zinc-chromate paint.
 - b. Copper suction screen.
 - c. Drain, overflow, and suction connections.
 - d. Makeup connection with brass float valve, and with quick-fill connection.
6. Insulate exterior with duct insulation and mount on 2-inch (50-mm) thick, rigid insulation board.

C. Evaporative Humidifier Section:

1. Access Door: Watertight with brass fittings, wire glass window, and locking handles.
2. Spray Tree Assembly: Brass nozzles and galvanized piping.
3. Tank:
 - a. Welded steel tank with interior and exterior surfaces blasted and painted with zinc-chromate paint.
 - b. Copper suction screen, drain, overflow, and suction connections.
 - c. Makeup connection with brass float valve, and with quick-fill connection.
4. Insulation: Insulate with duct insulation on exterior and mount on 2-inch (50-mm) thick, rigid insulation board.

2.17 AIR-TO-AIR ENERGY RECOVERY

A. Heat Wheels:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Airxchange.
 - b. American Energy Exchange, Inc.
 - c. Loren Cook Company.
 - d. SEMCO Incorporated.
 - e. Trane; American Standard Inc.

- f. Heatex
- 2. Casing:
 - a. Steel, with manufacturer's standard paint coating.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
- 3. Rotor: Aluminum, segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating. Construct media for passing maximum 500, 800 or 1200-micrometer solids.
- 4. Rotor: Glass-fiber Polymer segmented wheel, strengthened with radial spokes impregnated with non-migrating, water-selective, molecular-sieve desiccant coating. Construct media for passing maximum 800 or 1200-micrometer solids.
- 5. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller, and self-adjusting multilink belt around outside of rotor.
- 6. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Retain one of first three subparagraphs below.
 - c. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
 - d. Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
 - e. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain [exhaust temperature above freezing and] air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 - f. Pilot-Light Indicator: Display rotor rotation and speed.
 - g. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- B. Fixed-Plate Sensible Heat Exchangers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. American Energy Exchange, Inc.
 - b. Des Champs Technologies.
 - c. Exothermics Inc.; a brand of Eclipse, Inc.
 - d. Nutech Brands Inc.
 - e. RenewAire LLC.

- f. Heatex.
- 3. Casing: [Aluminum] [Galvanized steel] [Enameled steel, with galvanized-steel liner] [Enameled steel].
- 4. Plates: Evenly spaced and sealed and arranged for counter airflow.
- 5. Plate Material: [Embossed aluminum] [Stainless steel] [Polypropylene copolymer (high-density plastic)].
 - a. Coatings are available for aluminum plates in corrosive atmospheres.
 - b. Plate Coating: [Epoxy] [Air-dried phenolic].
- 6. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
- 7. Water wash and detergent injection are available optional features.
- 8. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock[, with detergent injection].
- 9. Heat-Exchanger Prefilters: [1 inch (25 mm) thick, disposable] [2 inches (50 mm) thick, disposable] [Medium efficiency] [Electrostatic].

C. Fixed-Plate Enthalpy Heat Exchangers:

- 1. Heat Exchanger Performance Requirements
 - a. The enthalpy plate exchanger shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.
 - b. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.
 - c. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.
 - d. The ERV core shall achieve a minimum of 50 % total energy recovery effectiveness tested at rated flows in heating conditions to AHRI 1060-2005 standards.
 - e. The ERV Core shall have a maximum pressure drop of 0.8" wg. as tested at the rated flow to AHRI 1060-2005.
 - f. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.
 - g. The ERV core shall have a 0% Exhaust Air Transport Ratio as tested to AHRI 1060-2005 (EATR) to prevent cross-over of gases, contaminants or odors.
 - h. The ERV core shall inhibit mold and bacteria growth as tested to Standard AATCC 30 with 100% surface inhibition on the Aspergillus mold test and 100% surface inhibition the Kirby Bauer Staphylococcus bacteria test.
 - i. The ERV core must be able to tolerate freezing temperatures of -30°C and not have an increase in EATR or decrease in performance after being frozen.
 - j. The ERV core must be able to tolerate high temperatures of +60°C and not have an increase in EATR or decrease in performance at these elevated temperatures.
 - k. The ERV core must be water washable to remove dust and contaminants.
 - l. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50

2. Frame and Inspection Requirements
 - a. The ERV shall have a frame consisting of 5052 series aluminum end plates and aluminum alloy 6063 extruded side rails.
 - b. Provide removable panels for inspection and cleaning of the heat transfer surface on the dirty air side without dismantling the system.
3. Heat-Exchanger Prefilters: 2 inches (50 mm) thick, disposable Medium efficiency
4. Manufacturer: dPoint Technology or approved equal.

2.18 ELECTRICAL HEATING COIL

- A. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Refer to schedule on drawings for voltage, capacity and staging.
- B. Coil Assembly: Comply with UL 1995.
- C. Heating Elements: Type A coiled resistance wire of 80 percent nickel and 20 percent chromium.
 1. Open Coil: Coils shall be machine crimped into stainless steel terminals extending at least 1" into the air stream and all terminal hardware shall be stainless steel. Coils shall be supported by ceramic bushings staked into supporting brackets. Maximum brackets spacing not to exceed 4-1/2" apart.
 2. Finned Tubular: Heating elements shall be finned tubular Type A resistance wire, precisely centered in a stainless steel tube and filled with granular magnesium oxide. The entire assembly is to be compacted to maximize both the heat transfer and dielectric properties of the magnesium oxide. After compacting the tube must be a minimum of 0.475" O.D. to provide sufficient insulation for operation up to 600 volts. A corrugated stainless steel fin is to be wrapped around the tube to increase its heat transfer surface. Both straight and U-bent elements are to be furnished with mounting flanges, making them individually removable from the terminal box. Element support brackets are not to be spaced more than 36" apart.
- D. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
- E. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- F. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) thick for flanged mounting.
- G. Control Panel: Unit mounted terminal box shall be NEMA-1, or NEMA-4 type construction when mounted exposed to weather, with disconnecting means and overcurrent protection. Include the following control features:
 1. Magnetic contactor.
 2. Mercury contactor.
 3. Toggle switches; one per step.
 4. Step controller.
 5. Time-delay relay.
 6. Pilot lights; one per step.

7. Airflow proving switch.

H. Manufacturers: Indeeco, Chromalox, Brasch, Dunham-Bush, Trane or equal.

2.19 AIR LEAKAGE TESTING

A. Before shipment the unit manufacturer shall factory pressure test (positive pressure) each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure. Testing shall be done on one unit of each type.

B. The test shall be conducted in accordance with SMACNA duct construction manual. A calibrated orifice shall be used to measure leakage airflow.

2.20 SOUND POWER LEVELS

A. Air handling unit sound power levels shall be submitted for review. Sound power data shall be given at the supply connections, return connections, outside air connections, and exhaust air connections in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from testing on the identical fans as used in the units. Data extrapolated from different fans is not acceptable.

B. Attenuation assumed for cabinet configuration, type of insulation, opening location and sizes shall be verified through actual test measurements. Sound power data is tested at the factory by an acoustical engineer in complete accordance with ARI 260-2001, "Sound Rating of Ducted Air Moving and Conditioning Equipment". These test reports will be submitted to the Architect before units ship from the factory.

C. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

Table 1: Maximum Allowable Sound Power Values per ARI 260 in dB re 1 picowatt

Unit ID	Source	Test	63	125	250	500	1K	2K	4K	8K
		ARI 260								
		ARI 260								
		ARI 260								
		ARI 260								

D. Fans to be tested in complete accordance with AMCA 300-1996, "Reverberant Room Method for Sound Testing of Fans", in a testing laboratory certified by AMCA to perform the test for both 210 performance and 300 sound. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

Table 2: Casing Radiated Maximum Allowable Sound Power Values per AMCA 300 in dB re 1 picowatt

Fan ID	Fan Type	63	125	250	500	1K	2K	4K	8K

PART 3 EXECUTION

3.01 EXAMINATION

- A. Install in accordance with manufacturer's instructions.
- B. Examine site to verify if site is ready to receive work. Provide a layout drawing of air handler and fan locations to electrical installer.
- C. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Air Handler Mounting:
 1. Base Mounted: Install air-handling units on equipment base as described and specified elsewhere
 - a. Concrete: Comply with requirements for equipment bases and foundations specified in Division 03.
 - b. If return fans are configured to drawing inlet air from a raised curb, curb access must be provided for field installation and service of measuring devices and smoke detectors.
 2. Suspended Mounting: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
 3. Vibration Isolators: Comply with requirements of 23 05 48 Vibration Isolation.
 4. Seismic Restraints: Comply with requirements for 23 05 49 Seismic Restraint.
 5. Arrange installation of units to provide access space around air-handling units for service and maintenance.
 6. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

7. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to air-handling unit to allow service and maintenance.
- D. Mount interior unit on vibration isolation springs.
- E. Mount rooftop unit on:
 1. Seismically restrained spring vibration isolation curb. Install with top surface of roof mounting frame level.
 2. Or, factory built roof mounting frame where vibration will not be perceptible to occupants. Install with top surface of roof mounting frame level.
- F. Install 3" flexible duct connection at inlets and outlets of units.
- G. Connect piping with flexible connectors.
- H. Connect condensate drain pans using ASTM B88, Type M or Type L copper tubing as shown on plumbing drawings and specifications. Extend to nearest roof receptor, floor sink, or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- I. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 - HVAC Piping, Valves and Specialties. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- J. Steam and Condensate Piping: Comply with applicable requirements in Section 23 21 13 - HVAC Piping, Valves and Specialties. Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.
- K. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 Refrigerant Piping Systems. Install shutoff valve and union or flange at each supply and return connection.
- L. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 23 31 13 - Air Distribution.
- M. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 31 13 - Air Distribution.
- N. Control installers shall install all wiring associated with control signals into the air handlers.

- O. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- P. Airflow measuring arrays installed in fan inlet volutes must be designed to withstand velocities encountered in this location. Mounting system is to be warranted against failure and consequent fan damage.

3.04 START-UP SERVICES

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, fill coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
 - 5. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
 - 6. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
 - 7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that zone dampers fully open and close for each zone.
 - 7. Verify that face-and-bypass dampers provide full face flow.

8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace sheaves, fan pulleys and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. ADJUSTING
1. Adjust damper linkages for proper damper operation.
 2. Comply with requirements in Section 23 05 93 Testing, Adjusting and Balancing.
- D. CLEANING
1. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.
- E. DEMONSTRATION
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.
- 3.06 AIR HANDLING UNIT CONFORMANCE
- A. Manufacturer representative shall complete the following table and provide a copy with each submittal package to assure conformance to specifications:
- B. Air Handler COMPLIANCE Checklist:

AIR HANDLER PERFORMANCE	
Manufacturer	
Dimensions (LxWxH inches)	
Operating Weight (LBS)	
Total Air Flow (CFM)	
System Supply Air Static Pressures (in. wg.)	
External Supply Ductwork	
Discharge Loss	
Cooling Coil	
Clean Filters	
Dirty Filter Allowance	
Damper/Louver/Fitting Loss	
Total Supply Fan Static	
Systems Return Air Static Pressures (in. wg.)	
External Return Air Static Pressure	
Entrance Loss	
Internal Louver/Damper/Fitting Loss	
Total Return Fan Static	
SUPPLY FAN PERFORMANCE	
Supply Fan BHP	
Supply Fan HP	
Supply Fan RPM	
Supply Fan Efficiency	
Direct Drive Plenum Fans	Yes or No

Fan Arrangement	
Pressure Class	
Aluminum Construction	Yes or No
Bearings (L 10/200000 hours)	Yes or No
Fans selected at rated motor RPM	Yes
RETURN FAN PERFORMANCE	
Return Fan BHP	
Return Fan HP	
Return Fan RPM	
Return Fan Efficiency	
Direct Drive Plenum Fans	Yes or No
Fan Arrangement	
Pressure Class	
Aluminum Construction	Yes or No
Bearings (L 10/200000 hours)	Yes or No
Fans selected at rated motor RPM	Yes
COIL PERFORMANCE	
Total Capacity (MBH)	
Sensible Capacity (MBH)	
Face Velocity (FPM)	
GPM	
Water Pressure Drop (ft. H ₂ O)	
Coils/Fins per Inch/Rows	
Tube Size (inches)	
Tube thickness (inches)	

Tube return bend thickness (inches)	
Coils have 16 ga 304 SS	Yes or No
Drain pans are 304 SS	Yes or No
Coil blank offs are 304 SS	Yes or No
CABINET CONSTRUCTION	
Structural Steel Channel base	Yes or No
Tubular steel base	Yes or No
Can vary base height	Yes or No
Structural steel channel cross support	Yes or No
Formed channel cross support	Yes or No
Cross support max spacing	
Thermal break at joints	Yes or No
Outer steel (gauge)	
Solid inner steel (gauge)	
Insulation (wall/floor thickness) (inches)	
Standing seam construction	Yes or No
Welded frame construction	Yes or No
Bolted construction	Yes or No
Sheet metal screw construction	Yes or No
Standing seam roof with seam cleats	Yes or No
Roof attachment external to unit casing	Yes or No
Outdoor-pitched roof	Yes or No
Access door locations as required	Yes or No
Double seals on doors	Yes or No
Latches per door (number)	
Adjustable door hinges	Yes or No

Adjustable door latches	Yes or No
Access doors open against static pressure	Yes or No
Door safety "Kill" switches	Yes or No
Polyurethane paint	Yes or No
Vents and drains extended to outside cabinet	Yes or No
Cabinet Sounds data for inlet & outlet	
Supply connection at 125 & 1000 hz (db)	
Return connection at 125 & 1000 hz (db)	
Economizer has min/max dampers	Yes or No
Dampers sizing (maximum fpm)	
Outside air louver sizing (maximum fpm)	
Exhaust air louver sizing (maximum fpm)	
Exterior hoods	Yes or No
ADDITIONAL UNIT FEATURES	
Marine lights with GFI	Yes or No
Fan screen enclosures	Yes or No
Min OSA air flow station	Yes or No
Airflow stations on each fan	Yes or No
Motor removal rails	Yes or No
Bellmouth outlet	Yes or No
Roof curb	Yes or No
TEFC premium efficiency motors	Yes or No
Shaft grounding factory mounted on motors	Yes or No
Variable Frequency Drive (VFD) manufacturer	

VFD's are factory mounted & wired (UL508)	Yes or No
Data sheets for VFD's	Yes or No
Filters are size and type specified	Yes or No
Filter frames are face load type 8	Yes or No
Two filter gages (one per filter bank)	Yes or No
Weather covers for filter gages	Yes or No
Data sheets for filters	Yes or No
Data sheets for air flow stations	Yes or No
PROVIDE DETAILS	
Base/floor construction	Yes or No
Casing/cabinet construction	Yes or No
Access doors	Yes or No
Door hinges and latches	Yes or No
Fan curves	Yes or No
Pressure losses (including internal/external loss)	Yes or No
Sound data for inlet/outlet	Yes or No
Electrical wiring diagram	Yes or No
Vibration isolation detail	Yes or No
Coil construction	Yes or No
VFD mounting details	Yes or No
MANUFACTURER CAPABILITIES	
Fan Wheel Manufacturer	
Coil Manufacturer	
Dampers Manufacturer	

Louver Manufacturer	
Isolator Manufacturer	
Have a certified UL508 electrical shop	Yes or No
ARI certified for coils	Yes or No
Coil Testing Capabilities	Yes or No
AMCA certified for blowers	Yes or No
UL-508	Yes or No
AMCA 210 accredited lab	Yes or No
AMCA 300 accredited lab	Yes or No
Ability to perform leak tests	Yes or No
UL-508 compliance	Yes or No
Unit ETL or UL listing	Yes or No

END OF SECTION

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SECTION 23 74 13

PACKAGED HVAC UNITS (UP TO 25 TONS)

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Packaged unit
 - 2. Controls and control connections
 - 3. Electrical power connections
 - 4. Roof mounting frame and base

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230700: Mechanical Insulation
- D. Section 233113: Air Distribution
- E. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA):
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans
 - c. 300 - Reverberant Room Method for Sound Testing of Fans
 - d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data

- e. 500 - Test Method for Louvers, Dampers, and Shutters
- 2. American National Standards Institute (ANSI):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units
- 3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 210/240 – Performance Rating of Unitary Air Conditioning & Air-Source Heat Pump Equipment
 - b. 270 - Sound Rating of Outdoor Unitary Equipment
 - c. 340/360 – Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
- 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Code for Mechanical Refrigeration
 - b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
- 5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
- 6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
- 7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
- 8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
- 9. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values listed in this specification.

1.05 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
 - 1. The proposed substitution does not affect dimensions shown on drawings.
 - 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
 - 3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
 - 4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product data for packaged units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. **Maintenance Data:** Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 1.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.09 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 PACKAGED ROOFTOP HEATING/COOLING UNIT (UP TO 20 TONS)

- A. **General:**
 1. Outdoor rooftop mounted, electrically controlled heating and cooling unit. Unit shall discharge supply air horizontally as shown on contract drawings. Down-discharge unit are not allowed for poor acoustical performance.
 2. Unit shall be rated in accordance with ARI Standards 210, 240 and 270. Designed in accordance with UL Standard 465.
 3. Unit shall be designed to conform to ANSI/ASHRAE 15.
 4. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards and CSA or CGA certified as a total package.
 5. Roof curb shall be designed to conform to NRCA Standards.

6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
- B. Manufacturers: Carrier, Trane, Daikin, York, Lennox, Aeon, Engineered-Air.
- C. Equipment:
1. General:
 - a. Factory assembled, single piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A) and special features required prior to field start-up.
 2. Unit Cabinet:
 - a. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
 - b. Insulation: See Table below.
 - c. Cabinet panels shall be easily removable for servicing. See Table below.
 - d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
 - e. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
 - f. Unit shall have a factory installed internal condensate drain trap made of a non-corrosive material, providing a minimum 3/4" connection.
 3. Fans:
 - a. Indoor blower (evaporator fan):
 - 1) Fan shall be direct or belt driven as specified here (See matrix below). If belt driven the drive shall include an adjustable pitch motor pulley.
 - 2) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
 - b. Indoor blower shall be made from steel with a corrosion resistant finish and shall be dynamically balanced.
 - c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.
 4. Compressor:
 - a. Fully hermetic type, internally protected.
 - b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
 - c. Equipped with a factory installed crankcase heater to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.
 5. Coils:
 - a. Evaporator and condenser coils shall have fins mechanically bonded to seamless tubes with all joints brazed.
 - b. Tube sheet openings shall be belled to prevent tube wear.
 - c. Evaporator coil shall be of the full-face active design, degreased at the factory.
 6. Heating Section:
 - a. Gas Heating Section:

- 1) Induced draft combustion type with intermittent direct spark ignition system and redundant main gas valve.
 - 2) Heat exchanger: See matrix below.
 - 3) All gas piping shall enter the unit cabinet at a single location.
- b. Electric Heating Section:
- 1) The rooftop unit shall include an electrical resistance heating coil section. The electric heating coil module shall be factory installed downstream of the supply air fan in the heating section of the rooftop unit.
 - 2) Heating elements shall be constructed of a low watt density, nickel - chromium alloy resistance wire with intermediate supports that include ceramic bushings. The electrical relay contactors shall be of the full line-breaking type with all the electrical power legs being disconnected when the contactors are not energized. All electrical circuit wiring shall be designed with copper conductors, aluminum wires are not acceptable. Heating element branch circuits shall be individually fused to a maximum of 48 Amps per NEC requirements. The rooftop unit shall have a single point power connection. The power supply for the electric heater shall be factory wired into the unit's main power block or disconnect switch.
 - 3) The heating modules shall have an automatic reset, high temperature limit safety protection. A secondary high limit protection shall also be provided that requires a manual reset. An airflow switch shall be provided with the heating module to prevent the electric heater from operating in the event of no airflow.
 - 4) The electric heater elements shall be controlled by the factory installed DDC unit control system. Control shall be per the matrix below.
 - 5) Field installed heating modules shall require a field ETL certification. Duct heaters mounted within the rooftop unit in the field shall not be acceptable. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the electric heating modules.
- c. Heat Pump Heating Section:
- 1) The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
 - 2) The refrigerant system shall have a pump-down cycle.
 - 3) The unit shall have a natural gas furnace for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.
 - 4) The unit shall have an electric resistance heating coil for auxiliary heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the electric heating coil shall temper the airstream to the discharge air temperature setpoint.
7. Refrigerant Components: Refrigerant circuit components shall include:
- a. Refrigerant feed system.
 - b. Filter drier.

- c. Service gauge connections on suction, discharge and liquid lines.
8. Filter Section:
- a. Standard filter section shall consist of factory installed low velocity, disposable filters of commercially available sizes.
 - b. Filter face velocity shall not exceed 500 fpm at nominal airflows.
9. Controls and Safeties:
- a. Unit Controls: Unit shall be complete with self-contained low voltage control circuit protected by a manually resettable circuit breaker.
 - b. Fault Detection and Diagnostics: Provide an on-board fault detection and diagnostics system capable of identifying specific faults including alarm for low refrigerant charge, failed economizer function.
 - c. Safeties:
 - 1) Unit shall incorporate a solid state compressor protector which provides reset capability at the space thermostat, should any of the following standard safety devices trip and shut off compressor:
 - (a) Compressor over temperature, overcurrent.
 - (b) Loss of charge/low pressure switch.
 - (c) Freezestat, evaporator coil.
 - (d) High-pressure switch.
 - 2) Gas Heating section shall be provided with the following minimum protections:
 - (a) High temperature limit switch.
 - (b) Induced draft motor centrifugal switch.
 - (c) Flame rollout switch (manual reset).
 - (d) Flame proving controls.
10. Operating Characteristics:
- a. Unit shall be capable of starting and running at 115°F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240.
 - b. Compressor with standard controls shall be capable of operation down to 25°F ambient outdoor temperature.
 - c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.
11. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory predrilled location.
12. Motors:
- a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
 - b. Indoor blower motor shall have permanently lubricated bearings and inherent automatic reset thermal overload protection.
 - c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.

- d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.
13. Small Package Rooftop Unit (1-1/2 -5 ton) Equipment Conformance List: The scheduled units within this size category shall be configured with the following selected feature options.

Small Package Rooftop Unit (1-1/2 – 5 ton)			
Equipment Requirements			
Component	Feature	Specification Options	Specified Alternative
Unit Case	Wall Construction	Single wall	X
		Double wall	
	Liner options	Foil faced insulation	X
	Insulation	1/2" Insulation	X
		1" insulation	
	Maintenance Access	Tool required	X
		Tool free	
		Hinged panels	
		Removable panels	X
	Condensate Pan	Plastic	
		Galvanized	X
Stainless			
Supply Fan	Fan Wheel Construction	Fully welded fan wheels	X
		Slot and tab wheel construction	
	Motor Type	ECM motor	
		Conventional	X
	Drive	Belt and sheaves	X
		Direct	
Relief Air	Relief provisions	Barometric damper only	X
		Prop relief fan with damper	
		Return fan	
Economizer		Fixed OSA damper	X

Small Package Rooftop Unit (1-1/2 – 5 ton)			
Equipment Requirements (Continued)			
Component	Feature	Specification Options	Specified Alternative
Compressor	Type of compressor	Scroll	X
		Digital Scroll	
		Variable speed	
Cooling Efficiency		SEER	See schedule
Evaporator	Coil Construction	Copper tubes/Aluminum fins	X
		Copper tubes/Copper fins	
		Epoxy coated Cu/Al coil	
Condenser	Coil Construction	Copper tubes/Aluminum fins	X
		Copper tubes/Copper fins	
		Coated condenser coil	
Reheat	Reheat Coil	Modulating hot gas reheat coil	
		Not required	X
Filters	Filter Type	1" filter	
		2" MERV 8 pleated filter	X
		2" MERV 13 pleated filter	
		4" MERV 13 pleated filter	
Electric Heat	Control	Step controller	
		SCR controller option	
Gas Heat	Type of Heat Exchanger (HEX)	Aluminized steel HEX	X
		Stainless HEX	
		Condensing Stainless HEX	
	Control	Stepped control	X

		Modulating control	
Hybrid Heat Pump/Gas Heat Option			
AFUE	Furnace Efficiency		See schedule

Small Package Rooftop Unit (1-1/2 – 5 ton)				
Equipment Requirements (Continued)				
Component	Feature	Specification Options	Specified Alternative	
Controls	Economizer	Full integrated 100% OSA economizer		
	Single Zone VAV controls			
	24/7 Programmable Thermostat		X	
	CO2 Sensor			
	Factory Digital Controls	Zone control by others		X
		Supply with zone control and interface panel		
	BAS Interface Options	BACnet interface		X
		LON Interface		
Smoke Detector	Provide with unit			
Electrical	Single Point Connection		X	
	Convenience outlet	Receptacle	X	

14. Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Conformance List: The scheduled units within this size category shall be configured with the following selected feature options.

Medium Size Package Rooftop Unit (7-1/2 -25 ton)			
Equipment Requirements			
Component	Feature	Specification Options	Specified Alternative
Unit Cabinet	Wall Construction	Single wall	X
		Double wall	
	Liner Options	Foil faced insulation	X
	Insulation	1/2" Insulation	
		1" insulation	X
	Maintenance Access	Tool required	
		Tool free	X
		Hinged panels	X
		Non-hinged panels	
	Condensate Pan	Plastic	
Galvanized		X	
Stainless			
Supply Fan	Fan Access	Slide out cassette	X
		Non-slide out	
	Fan Wheel Construction	Fully welded fan wheels	X
	Motor type	ECM motor	
		Conventional	X
	Drive	Belt and sheaves	
Direct		X	
OSA Intake	Fixed OSA		
	Economizer	Modulating dampers	X
Relief Air	Relief provisions	Barometric damper only	
		Prop relief fan with damper	X

		Return fan	
Compressor	Type of compressor	Scroll	X
		Digital Scroll	
		Variable Speed	
Cooling Efficiency		EER	See schedule
		IEER or SEER	See schedule
Evaporator	Coil Construction	Copper tubes/Aluminum fins	X
		Epoxy coated coil	
Condenser	Coil Construction	Copper tubes/Aluminum fins	X
		All aluminum coil	
		Copper tubes/Copper fins	
		Epoxy coated coil	
	Condenser fan	ECM type motor	X
		Constant speed motor	
Reheat	Reheat Coil	Modulating hot gas reheat coil	X
		Not required	
Filters	Filter type	2" MERV 8 pleated filter	X
		4" MERV 13 pleated filter	
Electric Heat	Control	Step controller	
		SCR controller option	X

Medium Size Package Rooftop Unit (7-1/2 -25 ton)				
Equipment Requirements (Continued)				
Component	Feature	Specification Options	Specified Alternative	
Gas Heat	Type of Heat Exchanger (HEX)	Aluminized steel HEX		
		Stainless HEX	X	
		Condensing Stainless HEX		
	Control	Stepped control		
		Modulating control	X	
Furnace Efficiency		See schedule		
Hybrid Heat Pump/Gas Heat Option				
HW Coil		Coil with modulating valve		
Heat Recovery		Heat wheel with filters, bypass dampers, and controls		
Controls	Economizer	Fully integrated economizer controls	X	
	Single Zone VAV			
	Full VAV Control		X	
	CO2 Sensor		X	
	OSA Monitor and controller		X	
	Heat recovery control			
	Dehumidification Control			
	Factory digital controls	Zone controls by others		X
		Equip with zone controls and unit programming panel		

	BAS interface options	BACnet interface	X
		LonTalk Interface	
	Smoke Detector	Provide with unit	X
Electrical	Single point connection		X
	Powered convenience outlet	Receptacle	X

15. Other Features and Required Equipment: Provide the following with units.

a. Roof Curb:

- 1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.
- 2) Seismically restrained spring isolating curb (See Section 230548 Vibration Seismic).

b. Head Pressure Control Package: Consists of solid-state control and condenser coil temperature sensor to maintain condensing temperature between 90°F and 110°F at outdoor ambient temperatures down to -20°F by either condenser fan speed modulation or condenser fan cycling.

c. LP Gas Kit: Package shall contain all the necessary hardware and instructions to convert a standard natural gas unit for use with liquefied propane gas.

d. Remote Control Panel: Panel shall be a decorative, indoor, wall mounted panel consisting of:

- 1) Two stage heat/two stage cool thermostat.
- 2) Automatic changeover.
- 3) System switch with HEAT - COOL - AUTO - OFF settings.
- 4) Fan switch with ON - AUTO settings.
- 5) Indicator lights for HEAT - COOL - FAN operation.
- 6) Three unused indicator lights for field use.

2.02 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365-day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.

1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One.

B. Minimum thermostat features shall include, but not limited to, the following:

1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.

2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
 3. The setback override shall be activated by a single button, and deactivated on demand.
 4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
 5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F
- C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
 2. An Emergency Heat switch will be provided on the touch screen when set in heat pump mode.
- D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.
- E. Controls shall be capable of alternating compressor starting sequence with a built in lead-lag operating logic.
1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.
- F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.
- G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.
- H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries.
- I. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surface, e.g. roof, is ready to receive work.

- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.
- C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. Mount rooftop unit on:
 - 1. Seismically restrained spring vibration isolation curb. Install with top surface of roof mounting frame level.
 - 2. Or, factory built roof mounting frame where vibration will not be perceptible to occupants. Install with top surface of roof mounting frame level.
- E. Install 3" flexible duct connection at inlets and outlets of units.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
 - 1. Install manufacturer provided condensate "air-trap" where provided with each unit. Install trap per manufacturer's instructions and install condensate piping as required by local code.
- G. Control installers shall install thermostat and all wiring associated with control signals into the units.
- H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- I. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

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SECTION 23 81 23

COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 GENERAL SUMMARY

- A. These specifications describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment.
- B. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room
- C. Section Includes:
 - 1. Floor-mounted computer-room air conditioners.
 - 2. Ceiling-mounted computer-room air conditioners.
 - 3. Console computer-room air conditioners.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 230500: Basic HVAC Materials and Methods
- C. Section 230900: Building Automation System (BAS) Controls
- D. Division 26: Electrical

1.04 DEFINITION

- A. BAS: Building automation system.

1.05 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7] <Insert requirement>**.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **[and the unit will be fully operational after the seismic event].**"

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
 - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from Installers of the items involved.
- B. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.08 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.09 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: **[One]** <Insert number> set(s) for each belt-driven fan.
 - 2. Filters: **[One]** <Insert number> set(s) of filters for each unit.

1.10 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Provide complete computer room air conditioning units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. **Codes and Standards:** Provide air handling units conforming to the requirements of the latest addition of the following:
1. **Air Movement and Control Association (AMCA):**
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans for Rating
 - c. 300 - Reverberant Room Method for Sound Testing of Fans
 - d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - e. 500 - Test Method for Louvers, Dampers, and Shutters
 2. **American National Standards Institute (ANSI):**
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units
 3. **Air-Conditioning, Heating and Refrigeration Institute (AHRI):**
 - a. 240 - Unitary Air-Source Heat Pump Equipment
 - b. 270 - Sound Rating of Outdoor Unitary Equipment
 4. **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):**
 - a. 15 - Safety Code for Mechanical Refrigeration
 5. **Electrical Components, Devices, and Accessories:**
 - a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - b. **National Electrical Manufacturers Association (NEMA):** Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 6. **National Fire Protection Association (NFPA):** Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
 7. **Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):** Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
 8. **Underwriters Laboratories, Inc. (UL):** Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
 9. **Minimum Efficiency:** Minimum efficiencies shall meet or exceed the values required by the local energy code.

- C. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.11 COORDINATION

- A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.
- C. Coordinate sizes and locations of concrete bases with actual equipment provided.
- D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.12 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 FLOOR-MOUNTED UNITS 6 TONS (21 KW) AND LARGER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Compu-Aire, Inc.
 - 2. Liebert Corporation.
 - 3. Stulz-ATS.
- B. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.
- C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
 - 1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.

2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- (25-mm-) thick duct liner.
 3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color [**as selected from manufacturer's standard colors**] [**to match computer equipment**].
 5. Floor Stand: Welded tubular steel, <Insert required height> high, with adjustable legs and vibration isolation pads.
- D. Supply-Air Fan(s):
1. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
 2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.
- E. Refrigeration System:
1. Compressors: Semihermetic reciprocating; with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps; with[**oil strainer, internal motor overload protection,**] resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 2. Compressors: Hermetic reciprocating; with[**oil strainer, internal motor overload protection,**] resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 3. Compressors: Hermetic scroll; with[**oil strainer, internal motor overload protection,**] resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 4. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 5. Refrigerant: [R-407C] [R-410A] <Insert type>.
 6. Refrigerant: R-407C or R-410A.
 7. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
 8. Integral, Water-Cooled Refrigerant Condenser: [Shell-and-tube type fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII] [Coaxial tube-in-tube type] with liquid-line stop valve and head-pressure-actuated, [two] [three]-way regulating valve. Terminate fluid connections outside cabinet.
 - a. Cooling Medium: [**Water**] [**Glycol solution**].
 9. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel[**and disconnect switch**]. Control capacity by [**cycling fans**] [**modulating fan speeds**] [**three-way refrigerant bypass with receiver and isolation valve**].

- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating **[two]** **[three]**-way control valve.
1. Cooling Medium: **[Water]** **[Glycol solution]**.
 2. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: **[3 psig (21 kPa)] [5 psig (35 kPa)] <Insert value>** at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 3. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
- G. Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, multiple direct-drive propeller fans with fan guards, and single-phase motors with internal overload protection and integral electric control panel. Control capacity by cycling fans.
1. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing **[one]** **[two]** centrifugal pump(s) with mechanical seals; electrical-control cabinet with starters, lead-lag switch, automatic switchover, and alarm light.
1. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, check valves in pump discharge, unions, and pressurized expansion tank with air purge vent and system-charging connection.
 2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
 3. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- I. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of three stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.
- J. Refrigerant Heating Coil: Hot-gas coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first-stage refrigerant circuit.
- K. Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve and strainer.
1. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: **[3 psig (21 kPa)] [5 psig (35 kPa)] <Insert value>** at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- L. Steam Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve, strainer, and float-and-thermostatic trap.
1. Control Valve: Class 125 body.

- a. Maximum Pressure Drop (15-psig (103-kPa) Steam): 80 percent of inlet steam pressure.
 - b. Close-Off (Differential) Pressure Rating: 150 percent of operating (inlet) pressure.
- M. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame[**with 2-inch- (50-mm-) thick, disposable, glass-fiber prefilter**].
1. Thickness: [2 inches (50 mm)] [4 inches (100 mm)].
 2. Initial Resistance: **<Insert inches wg (Pa)>**.
 3. Recommended Final Resistance: **<Insert inches wg (Pa)>**.
 4. Arrestance (ASHRAE 52.1): [**90**] **<Insert number>** percent.
 5. Merv (ASHRAE 52.2): [**7**] **<Insert value>**.
- N. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and using condensate water from cooling coils with stainless-steel or brass float-valve mechanism; located in bypass airstream; with flush-cycle timer and solenoid drain valve.
- O. Evaporative Pan Humidifier: Stainless-steel pan and cover, serviceable without disconnecting water, drain, or electrical connections; prepiped with stainless-steel or brass float-valve mechanism; electric-resistance heating coil; low-water-cutoff switch; flush-cycle timer; and solenoid drain valve.
- P. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
 2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
 3. Drain Cycle: Field-adjustable drain duration and drain interval.
- Q. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.
- R. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- S. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.
1. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
 2. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.

3. Location: Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.
- T. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
1. Malfunctions:
 - a. Power loss.
 - b. Loss of airflow.
 - c. Clogged air filter.
 - d. High room temperature.
 - e. Low room temperature.
 - f. High humidity.
 - g. Low humidity.
 - h. Smoke/fire.
 - i. Water under floor.
 - j. Supply fan overload.
 - k. Compressor No. 1 - Overload.
 - l. Compressor No. 1 - Low Pressure.
 - m. Compressor No. 1 - High Pressure.
 - n. Compressor No. 2 - Overload.
 - o. Compressor No. 2 - Low Pressure.
 - p. Compressor No. 2 - High Pressure.
 2. Digital Display:
 - a. Control power on.
 - b. Humidifying.
 - c. Dehumidifying.
 - d. Compressor No. 1 - Operating.
 - e. Compressor No. 2 - Operating.
 - f. Heat operating.
 - g. Economy cooling.
 3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
 4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.

Retain first subparagraph below if interface with the BAS is through hardwired points and minimal interface is required.

- a. Hardwired Points:

- 1) Monitoring: On-off status, [common trouble alarm] [space temperature] [space relative humidity] <Insert monitoring point>.
 - 2) Control: On-off operation, [space temperature set-point adjustment] [space relative humidity set-point adjustment] <Insert control point>.
- b. **[ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol] <Insert type of interface>** communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.02 FLOOR-MOUNTED UNITS 5 TONS (18 KW) AND SMALLER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Compu-Aire, Inc.
 2. Liebert Corporation.
 3. Stulz-ATS.
- B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.
- C. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch- (25-mm-) thick duct liner.
1. Floor Stand: Welded tubular steel, <Insert required height> high, with adjustable legs and vibration isolation pads.
 2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.
- E. Refrigeration System:
1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
 2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 3. Refrigerant: [R-407C] [R-410A] <Insert type>.
 4. Refrigerant: R-407C or R-410A.
 5. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
 - a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
 6. Integral, Water-Cooled Refrigerant Condenser: Brazed-plate type with liquid-line stop valve and head-pressure-actuated, two-way regulating valve.
 - a. Cooling Medium: **[Water] [Glycol solution]**.

7. Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with **[propeller]** **[centrifugal]** fan, **[direct]** **[belt]** driven.
 8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve.
1. Cooling Medium: **[Water]** **[Glycol solution]**.
 2. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
- G. Remote Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motors with internal overload protection.
1. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
1. Piping: Interconnecting piping, from suction to discharge, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
 2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
 3. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- I. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
- J. Filter: 2-inch- (50-mm-) thick, disposable, glass-fiber media.
1. Initial Resistance: **<Insert inches wg (Pa)>**.
 2. Recommended Final Resistance: **<Insert inches wg (Pa)>**.
 3. Arrestance (ASHRAE 52.1): **[90]** **<Insert number>** percent.
 4. Merv (ASHRAE 52.2): **[7]** **<Insert value>**.
- K. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and located in bypass airstream; with flush-cycle timer and solenoid drain valve.
- L. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
 2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.

3. Drain Cycle: Field-adjustable drain duration and drain interval.

M. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

N. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- [**and humidity**]-control modules[, **humidity contactor**], time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch[, **adjustable humidity set point**,] and adjustable temperature set point.

2.03 CEILING-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Compu-Aire, Inc.
2. Liebert Corporation.
3. Stulz-ATS.

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches (610 by 1220 mm).

C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches (610 by 1220 mm), with filter.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.

E. Refrigeration System:

1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
3. Refrigerant: [R-22] [R-407C] [R-410A] <Insert type>.
4. Refrigerant: R-407C or R-410A.
5. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
6. Integral, Water-Cooled Refrigerant Condenser: [**Coaxial, counterflow, tube-in-tube**] [**Brazed-plate**] type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.

- a. Cooling Medium: **[Water] [Glycol solution]**.
 7. Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with **[propeller] [centrifugal]** fan, direct driven.
 8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.
1. Cooling Medium: **[Water] [Glycol solution]**.
 2. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
- G. Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motors with internal overload protection.
- H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
1. Piping: Interconnecting piping, to and from remote, air-cooled glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
 2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
- I. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor, dehumidification relay, and high-temperature-limit switches.
- J. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
1. Initial Resistance: **<Insert inches wg (Pa)>**.
 2. Recommended Final Resistance: **<Insert inches wg (Pa)>**.
 3. Arrestance (ASHRAE 52.1): **[90] <Insert number>** percent.
 4. Merv (ASHRAE 52.2): **[7] <Insert value>**.
- K. Atomizing Humidifier: Centrifugal atomizer with stainless-steel pan, demister pad, and solenoid valve.
- L. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
 2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
 3. Drain Cycle: Field-adjustable drain duration and drain interval.
- M. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

- N. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- [**and humidity**]-control modules[, **humidity contactor**], time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch[, **adjustable humidity set point**,] and adjustable temperature set point.

2.04 CONSOLE UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Compu-Aire, Inc.
 2. Liebert Corporation.
 3. Stulz-ATS.
- B. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.
- C. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.
1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.
- E. Refrigeration System:
1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
 2. Refrigeration Circuit: Filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 3. Refrigerant: [R-407C] [R-410A] <Insert type>.
 4. Refrigerant: R-407C or R-410A.
 5. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
 6. Integral, Water-Cooled Refrigerant Condenser: [**Coaxial, counterflow, tube-in-tube**] [**Brazed-plate**] type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.
 7. Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with [**propeller**] [**centrifugal**] fan, direct driven.
 8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve.

1. Cooling Medium: [**Water**] [**Glycol solution**].
2. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].

Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motor with internal overload protection.

- G. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
1. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
 2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F (minus 40 deg C).
- H. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
- I. Filter: Cleanable.
- J. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
1. Initial Resistance: <Insert inches wg (Pa)>.
 2. Recommended Final Resistance: <Insert inches wg (Pa)>.
 3. Arrestance (ASHRAE 52.1): [90] <Insert number> percent.
 4. Merv (ASHRAE 52.2): [7] <Insert value>.
- K. Electrode Steam Humidifier: Self-contained and microprocessor controlled; with replaceable cylinder.
- L. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- M. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature-[and humidity-]control modules. Provide solid-state, unit-mounted control panel with start-stop switch[, adjustable humidity set point,] and adjustable temperature set point.

2.05 FAN MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
- B. <Insert unique motor characteristics>.

2.06 REQUIRED OPTIONS

- A. Firestat
 - 1. The firestat shall immediately shut down the environmental control system when activated. The firestat shall be mounted in the electrical panel with the sensing element in the return air.
- B. Automatic Shut-off Valve
 - 1. Provide an automatic two-position valve on the chilled water return line.
- C. Leak Detection
 - 1. Local sensing at units: (Max of two per unit)
 - 2. Cable leak detection for underfloor plenum.
 - a. Provide 45 ft long leak detection cable. Upon detection of a leak, both the chilled water control valve (supply line) and shut-off valve (return line) shall close.
- D. Seismic Floor Stand
 - 1. The seismic floor stand shall be constructed of a heliarc welded tubular steel frame. The floor stand shall have adjustable legs with vibration isolation pads. The floor stand shall be ___ inches high.
- E. Floor Stand Turning Vane
 - 1. A factory supplied, field mounted turning vane shall be provided.
- F. Temperature and humidity Recorder
 - 1. Provide a 7 day/24 hour temperature and humidity recorder of the full scope, two pen, surface mounted type with 100 recording charts, one red and one blue bottle of recording ink. Recorder shall be a 110 volt, single phase, 60 Hz (50 Hz) power supply.
- G. Lock-Out Relays
 - 1. Provide lock-out relays for the humidifier and reheat. Relays shall lock-out humidifier and reheat upon loss of the primary power feed to the air conditioning unit.
- H. Smoke Detector
 - 1. The smoke detector shall immediately shut down the environmental control system and active the alarm system when activated. The smoke detector shall be mounted in the electrical panel with the sensing element in the return air compartment.
- I. Remote Shutdown.
 - 1. Provide contacts for remote shutdown of unit by area smoke detection system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. [**Install according to ARI Guideline B.**]
- B. Computer-Room Air-Conditioner Mounting: Install using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**] <Insert device>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**]
 - 1. Minimum Deflection: [**1/4 inch (6 mm)**] [**1 inch (25 mm)**] <Insert dimension>.
- C. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and [**elastomeric hangers**] [**spring hangers**] [**spring hangers with vertical-limit stop**] of size required to support weight of computer-room air conditioner.
 - 1. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**] Fabricate brackets or supports as required.
 - 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- D. Air-Cooled Refrigerant Condenser Mounting: Install using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**] <Insert device>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**]
 - 1. Minimum Deflection: [**1/4 inch (6 mm)**] [**1 inch (25 mm)**] <Insert dimension>.
- E. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**] <Insert device>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**]
 - 1. Minimum Deflection: [**1/4 inch (6 mm)**] [**1 inch (25 mm)**] <Insert dimension>.
- F. Glycol-Solution Pump Package Mounting: Install using [**elastomeric pads**] [**elastomeric mounts**] <Insert device>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**]

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

- D. Hot-Water Heating Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to heating coils.
- E. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Piping Specialties." Provide shutoff valves in steam inlet and steam trap in condensate outlet piping to heating coils.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
 - 1. Install manufacturer provided condensate "air-trap" where provided with each unit. Install trap per manufacturer's instructions and install condensate piping as required by local code.
- G. Condenser-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Provide shutoff valves in water inlet and outlet piping on water-cooled units.
- H. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.04 FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. After startup service and performance test, change filters and flush humidifier.

3.05 ADJUSTING

- A. Adjust initial temperature[**and humidity**] set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

- C. Occupancy Adjustments: When requested within **[12] <Insert number>** months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **[two] <Insert number>** visits to Project during other-than-normal occupancy hours for this purpose.

3.06 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

SECTION 23 81 30
SPLIT AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
 - 1. Split air conditioning unit.
 - 2. Controls and control connections.
 - 3. Electrical power connections.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00 - Basic HVAC Materials and Methods
- B. Section 23 05 93 - Testing, Adjusting and Balancing
- C. Section 23 07 16 - Equipment Insulation
- D. Section 23 09 00 - Building Automation System (BAS) Controls
- E. Section 23 23 00 - Refrigerant Piping Systems
- F. Section 23 31 13 - Air Distribution
- G. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA):
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans for Rating

2. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 210 - Unitary Air-Conditioning Equipment
 - b. 270 - Sound Rating of Outdoor Unitary Equipment
3. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
4. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
5. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
6. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
7. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values required by the local energy code.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.
- C. Provide five (5) year warranty on compressors.

PART 2 PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING SYSTEM WITH INDOOR FAN COIL

- A. Manufacturers: Mitsubishi, Samsung, or Daikin.
- B. Indoor Fan Coil Unit
 - 1. General:
 - a. Factory fabricated wall or ceiling mounted fan coil units designed for ductless application of the size, type configuration and capacity as scheduled on the drawings.
 - b. Units shall be self-contained, factory assembled and pre-wired.
 - c. All pressure drops, motor horsepower and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
 - d. Manufacturers unable to meet this criterion will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
 - e. Units shall be provided with factory welded mounting clips for mounting of units.
 - 2. Unit Casing: Cabinet and grilles shall be zinc-coated bonderized steel finished with baked enamel paint or powdered coated finish. Grilles may be high-impact plastic.
 - 3. Fan Assembly: Fan shall be direct drive with forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel. Rotating assembly shall provide a rigid support for motor and fan assembly. Assembly shall be accessible and entire assembly shall be removable for maintenance.
 - 4. Motors: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection or electrically commutated (EC). Fan motor to be multi-speed as specified on Drawings.
 - 5. Coils: Coils shall be copper tube with ARI certified and of the same manufacturer as the unit to insure proper fit and quality mechanical bond. No exposed copper shall show between fins. Coils drip pan shall be galvanized steel coated with closed cell fire retardant foam insulation. A secondary drip pan shall be included under the coil header.
 - 6. Filter Section: Filters shall be factory supplied cleanable filter or one-inch thick pleated.
 - 7. Electrical: Unit electrical power shall be 115 volts, 1 phase, 60 hertz, or as specified on Drawings.
- C. Outdoor Condensing Unit:
 - 1. General: Provide remote outdoor air conditioning compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve.

2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.
3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Condenser fan openings to be equipped with PVC-coated steel wire safety guards. Fan blades to be statically and dynamically balanced.
4. Coil: Aluminum fins mechanically bonded to copper tubes.
5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.
6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit. A crankcase heater shall be factory mounted on the outside of the compressor.
7. Electrical: Unit electrical power shall be 208/230 volts, 1 phase, 60 hertz, or as specified on Drawings. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.

D. Controls:

1. Unit shall have a factory wired temperature controller to perform input functions necessary to operate the system.
2. The controller shall consist of an on/off switch, thermostat setting, timer mode, high/medium/low fan speed, test run switching and check mode switching. Provide with 365-day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
3. Temperature changes shall be by 2°F increments with a range of 65 - 87°F (minimum).
4. The control system shall consist of two (2) microprocessors interconnected by a single non-polar two wire cable.
5. Wiring shall run direct from the indoor unit to the controller with no splices.
6. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.
7. Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room.
8. The control voltage from the controller to the indoor unit shall be 12 volts, DC.
9. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.
10. The system shall be capable of automatic restart when power is restored after power interruption.
11. The system shall include self-diagnostics including total hours of compressor run time.
12. The microprocessor within the wall mounted remote controller shall provide automatic cooling, display set point and room temperature, 24 hour on/off timer so that automatic operation function display, check mode for memory of most recent problem.

13. Fan only operation shall be provided to permit room circulation when no cooling is required.
14. Compressor time delay to limit cycling.

E. Special Features:

1. Provide an internal condensate pump with interlock to unit operation in the event of malfunction.
2. Provide external electronic programmable thermostat.
3. Low ambient control capable of operating at 0°F ambient temperature.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive work.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.
- C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
- E. Provide 4" high concrete pad extending 6" beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.
- G. Install copper refrigerant piping and insulate lines.
- H. Install controller and all wiring associated with control signals between air handling unit and condensing unit. Conceal low voltage wiring in building structure, or inside the refrigerant pipe insulation, or in conduit.
- I. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- J. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 81 46

WATER SOURCE HEAT PUMP UNITS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, the following:
 - 1. Water source heat pump unit
 - 2. Controls and control connections
 - 3. Electrical power connections

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230716: Equipment Insulation
- D. Section 230900: Building Automation System (BAS) Controls
- E. Section 232113: Hydronic Piping, Valves, and Specialties
- F. Section 232133: Ground-Source Heat-Pump Piping
- G. Section 233113: Air Distribution
- H. Division 26: Electrical

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Ground Source Application: If the heat pump is to be used in a ground coupled system, the heat pump must meet the standards of the IGSHPA.
- C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:

1. Air Movement and Control Association (AMCA):
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans for Rating
 - c. 300 - Reverberant Room Method for Sound Testing of Fans
 - d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - e. 500 - Test Method for Louvers, Dampers, and Shutters
2. American National Standards Institute (ANSI):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units
3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 320 - Water Source Heat Pump Equipment operating between 60-85°F.
 - b. 325 - Water Source Heat Pump Equipment operating between 45-85°F.
 - c. 330 - Water Source Heat Pump Equipment operating between 25-115°F.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Code for Mechanical Refrigeration
 - b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
8. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values required by the local energy code.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.
- C. Provide with five (5) year warranty on compressors.

PART 2 PRODUCTS

2.01 GENERAL

- A. The heating/cooling units shall be suspended (vertical) type with horizontal (bottom discharge) air inlet and (top) discharge. Units shall be AHRI Standard performance certified for the operating temperature ranges scheduled and listed by a nationally recognized safety-testing laboratory or agency, such as ETL Testing Laboratory or Canadian Standards Association (CSA). Each unit shall be computer run tested at the factory.
- B. The units shall be designed to operate with entering liquid temperature between 25°F and 110°F
- C. The units shall be connected to the building automation system (BAS). The controls contractor shall review the sequence of operation identified below and coordinate with each approved equipment manufacturer to provide the designated points either through the interface or a hard wire connection (at no additional cost) where capability is not available through the interface.
- D. Manufacturers: Carrier, Trane, Daikin, ClimateMaster, WaterFurnace, or Florida Heat Pump.

2.02 CASING AND CABINET

- A. The cabinet shall be fabricated from heavy-gauge galvanized steel and finished with corrosion-resistant electrostatic powder coating. The interior shall be insulated with a minimum of ½" thick, multi-density, coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air. One or two blower compartments and three compressor compartment access panels shall be provided and shall be removable with supply and return ductwork in place. The internal component layout shall provide for major service with the unit in-place for restricted access installations.
- B. A duct collar shall be provided on the supply air opening. The units shall have an insulated divider panel between the air handling section and the compressor section to minimize the transmission of compressor noise, and to permit operational service testing without air bypass. Horizontal units shall be supplied with left or right air inlet, and side or end air discharge.

2.03 REFRIGERANT CIRCUIT

- A. LEED Project Refrigerant Requirements: Provide charged with a refrigerant meeting one or both of the following options:
 - 1. Non-HCFC Refrigerant: Provide equipment designed and charged for operation at scheduled and specified stated efficiencies using a non-HCFC refrigerant.
 - 2. Provide documentation that the refrigerant/equipment combination will meet the LEED □ Technical and Scientific Advisory Committee HCFC Task Group requirements as described in their report, The Treatment by LEED of the Environmental Impact of HVAC Refrigerants. This means that the equipment falls into the "acceptable region" of global warming vs. ozone depletion performance as defined in the report.
- B. All units shall contain a scaled refrigerant circuit including a hermetic motor-compressor, bidirectional thermal expansion valve, finned tube air-to-refrigerant exchanger, reversing valve, coaxial tube water-to-refrigerant heat exchanger, and service ports.
- C. Compressors shall be high-efficiency designed for heat pump duty and mounted on vibration isolators. Compressor motors shall be single-phase PSC with external overload protection.
- D. The finned tube coil shall be sized for low face velocity and constructed of lanced aluminum fins bonded to rifled copper tubes in a staggered pattern not less than three rows deep.
- E. The coaxial water-to-refrigerant heat exchanger and refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures.
- F. Optional: Provide a domestic hot water desuperheater for preheating of domestic water. Unit shall include double-wall vented refrigerant-to-water heat exchanger, water pump powered by a sealed magnetic drive motor, water line thermostat, secondary safety thermostat to prevent scalding, internal fuse, internally mounted disconnect switch, air bleed port, and refrigerant ports. Units shall be UL listed.

2.04 FAN MOTOR AND ASSEMBLY

- A. The fan shall be a direct drive centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet low outlet velocity operation. Tight fan housing geometry shall not be permitted. The fan housing shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor. The fan motor shall be a variable-speed ECM2 type. The ECM2 fan motor shall be soft-starting, shall automatically maintain constant CFM over its operating static range, and shall provide 12 field selectable CFM settings. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be a permanently lubricated long-life ball bearing type and have thermal overload protection.

2.05 FILTERS

- A. Provide 2" thick replaceable filter with a mean efficiency of 35% tested in accordance with ASHRAE 52.1. Mount filters in filter frames and provide access panels or doors for removal and replacement.

2.06 ELECTRICAL

- A. A microprocessor-based controller shall be provided that interfaces with a multistage electronic thermostat to monitor and control unit operation. The control shall provide operational sequencing, fan and compressor speed control, high and low pressure switch monitoring, high compressor temperature sensing, freeze protection and hot water limit thermistor sensing, fan failure, condensate overflow sensing, auxiliary heat staging, lockout mode control, hot water and staged loop pump control, LED status and fault indicators, fault memory, field selectable options and accessory output.
- B. A removable terminal block with screw terminals shall be provided for field low-voltage wiring. A circuit breaker protected 75VA low-voltage transformer shall be provided.
- C. Line voltage terminal blocks or connection lugs shall be provided for unit and loop pump wiring. Units shall have knockouts for entrance of low and line voltage wiring. The fan motor and control box shall be harness plug-connected for easy removal.
- D. The unit is to be supplied with a unit mounted fused disconnect switch.

2.07 PIPING

- A. Supply and return water connections shall be brass swivel fittings which provide a union and eliminate the need for pipe wrenches and sealants when making field connections. All water piping shall be insulated to prevent condensation at low liquid temperatures. The condensate connection shall be a 3/4" PVC socket with internally-trapped hose (vertical units only) which can be routed to front or side locations.

2.08 HANGER KIT

- A. The hanger kit shall consist of galvanized steel brackets, bolts, lock washers, and isolators and shall be designed to fasten to the unit bottom panel for suspension from 3/8" threaded rods.

2.09 REQUIRED ACCESSORIES AND OPTIONS

- A. Proof of Operation contacts to be used by the control contractor for proof and/or interlock to associated relief fan.
- B. Thermostat: Thermostat shall be 7 day programmable, multi-stage (3H/2C), manual or automatic change over with HEAT-OFF-COOL-AUTO system settings and fan ON-AUTO settings. Thermostat shall have an LCD display with temperature, setpoints, mode, and status indication. The temperature indication shall be selectable for °F or °C. A System Test feature shall be provided to simplify troubleshooting. The thermostat shall provide permanent memory of setpoints and program without batteries. A fault LED shall be provided. Thermostat shall provide optional extended end of cycle fan operation, heating setpoint range limit, cooling setpoint range limit, temperature display offset, temperature display disable, keypad lockout, dead-band range setting, and inter-stage differential settings. Thermostat shall provide capability to average from 1 to 9 remote sensors.

- C. The unit will be supplied with internally factory mounted motorized two-way water valve interlocked with compressor operation for variable speed pumping requirements.
- D. A Low noise package consisting of high technology sound attenuating materials that are strategically applied to the cabinet, in addition to the standard insulation system, to further dampen sound.
- E. Provide heat pump with extended range capability and electric resistance heat to permit the unit to provide heating at low condenser water temperatures.
- F. Controls shall prevent the operation of supplemental electric resistance heating when the heating load can be served by the heat pump alone.

2.10 PROGRAMMABLE THERMOSTAT

- A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
 - 1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One.
- B. Minimum thermostat features shall include, but not limited to, the following:
 - 1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
 - 2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
 - 3. The setback override shall be activated by a single button, and deactivated on demand.
 - 4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
 - 5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F
- C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
 - 1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
 - 2. An Emergency Heat switch will be provided on the touch screen when set in heat pump mode.
- D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.
- E. Controls shall be capable of alternating compressor starting sequence with a built in lead-lag operating logic.

1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.
- F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.
- G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.
- H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive work.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.
- C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
- E. Install 2" flexible duct connection at inlets and outlets of ducted units.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
 1. Install manufacturer provided condensate "air-trap" where provided with each unit. Install trap per manufacturer's instructions and install condensate piping as required by local code.
- G. Control installers shall install thermostat and all wiring associated with control signals into the units.

- H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- I. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 81 58

VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Condensing Units
 - a. Air Cooled Condensing Unit – Heat Pump (heat or cool model)
 - b. Air Cooled Condensing Unit – Heat Recovery (heat and cool model)
 - c. Water Cooled Condensing Unit – Heat Pump/Heat Recovery
 2. Branch Selector (BS) Units or Branch Circuit (BC) Terminal for Heat Recovery systems.
 3. Indoor Fan Coil Units:
 - a. Non-ducted Recessed Ceiling Cassette Units
 - b. Ducted Concealed Ceiling Fan Coil Units
 - c. Ceiling Suspended Unit
 - d. Wall Mounted Unit
 - e. Floor Console Unit
 - f. Floor Console Concealed Unit
 - g. Vertical/horizontal Air Handling Unit
 4. 100% OSA Makeup Air Units – 100% OSA Processing Unit
 5. Controls
 6. Refrigerant gas monitors

1.03 SYSTEM DESCRIPTION

- A. Heat Pump (heat or cool model)
1. The variable capacity heat pump air conditioning system shall be a VRV/VRF series heat or cool model. The system shall consist of multiple evaporators, heat pump condensing unit with variable speed inverter driven compressors, and PID DDC (direct digital controls). All zones are each capable of operating separately with individual temperature control.

2. Operation of the system shall permit either cooling or heating of all of the indoor units simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BAS interface.

B. Heat Recovery (heat and cool model)

1. The variable capacity heat pump air conditioning system shall be a VRV/VRF series heat and cool model. The system shall consist of multiple evaporators, Branch Selector Units or Branch Circuit Terminals, heat recovery condensing unit with variable speed inverter driven compressors, and PID DDC (direct digital controls). All zones are each capable of operating separately with individual temperature control.
2. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BAS interface.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 00: Basic HVAC Materials and Methods
- B. Section 23 05 93: Testing, Adjusting and Balancing
- C. Section 23 07 16: Equipment Insulation
- D. Section 23 23 00: Refrigerant Piping Systems
- E. Section 23 31 13: Air Distribution
- F. Division 26: Electrical

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 1. Air Movement and Control Association (AMCA):
 - a. 99 - Standards Handbook
 - b. 210 - Laboratory Methods of Testing Fans
 - c. 300 - Reverberant Room Method for Sound Testing of Fans
 - d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - e. 500 - Test Method for Louvers, Dampers, and Shutters
 2. American National Standards Institute (ANSI):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings
 - b. 11 - Load Ratings and Fatigue Life for Roller Bearings
 - c. 900 - Test Performance of Air Filter Units

3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 1230 - Variable Refrigerant Flow Multi-Split Air –conditioners and Heat Pumps
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Code for Mechanical Refrigeration
 - b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL. This includes condensate pumps and other ancillary devices required for operation.
9. Electrical Laboratories (ETL): The units shall be listed by ETL and bear the ETL label.
10. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values required by the local energy code.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.

- B. Store/protect products under provisions of Division 01 and according to manufacturer's recommendation. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.09 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.
- C. Provide extended warranty for compressors for a six (6) year period.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Daikin VRV III and IV, Mitsubishi City Multi, or equal.

2.02 CONDENSING UNIT

- A. General:
 1. The outdoor unit shall be designed for used with an integrated variable refrigerant flow zone system.
 2. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
 3. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 4. (Heat Recovery Only) Refrigerant lines from the outdoor unit to the BS or BC unit shall be individually insulated between the condensing and fan coil units.
 5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
 6. The connection ratio of fan coil units to condensing unit shall be permitted up to 150% of outdoor rated capacity.
 7. Each condensing system shall be able to support the connection of up to 50 indoor units dependent on the model of the condensing unit.
 8. The sound pressure level standard shall no greater than 65 dBA at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time.
 9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
 10. Water-cooled only:
 - a. Each condensing unit shall have a 240VAC, 0.3mA-0.5A control circuit output for water pump or isolation valve operation. This circuit shall be configured at commissioning to operate based on system or compressor operation.

- b. Each condensing unit shall incorporate normally open, 15VDC and 1.0mA rated contacts for integration of a mandatory flow proving device.
11. The unit shall incorporate an auto-charging feature.
 12. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
 13. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 14. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
 15. Each system shall maintain continuous heating during oil return operation.
 16. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
 17. (Heat Recovery only) The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.
- B. Unit Cabinet:
1. Air Cooled: The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
 2. Water Cooled: The condensing unit shall be corrosion resistant. The unit shall be constructed from rust-proofed, mild steel panels coated with a baked enamel finish.
- C. Fan (air-cooled models only):
1. The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
 2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.24 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
 3. The fan shall be a vertical discharge configuration.
 4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
 5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
 6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature.
- D. Condenser Coil (air-cooled):
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
 3. The fins are to be covered with an anti-corrosion finish.

- E. Condenser Heat Exchanger (water-cooled):
1. The condenser heat exchanger shall be a stainless brazed plate type designed for closed loop/dry cooler applications.
 2. The heat exchanger shall have a maximum system water pressure of 285 psi (equivalent to 640ft of head).
- F. Compressor:
1. The inverter driven scroll hermetic compressors shall be variable speed controlled capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
 2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll type
 3. The capacity control range shall be as low as 4% to 100%.
 4. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
 5. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 6. Oil separators shall be standard in the equipment together with an intelligent oil management system.
 7. The compressor shall be spring mounted to avoid the transmission of vibration.
- G. Electrical:
1. The power supply to the condensing unit shall be as shown on the drawings.
 2. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2-conductor cable.
 3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

2.03 BRANCH SELECTOR (BS) BOX/ BRANCH CIRCUIT (BC) CONTROLLER FOR HEAT RECOVERY SYSTEM

- A. General: Branch selector boxes/ Branch circuit controllers are designed specifically for use with heat recovery system components.
1. Selector boxes / circuit controllers shall be factory assembled, wired, piped and run tested at the factory.
 2. Selector boxes / circuit controllers must be mounted indoors.
 3. When simultaneously heating and cooling, the units in heating mode shall energize their sub-cooling electronic expansion valve.
- B. Unit Cabinet:
1. These units shall have a galvanized steel plate casing.
 2. Each cabinet shall house multiple electronic expansion valves for refrigerant control per branch.

3. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Refrigerant Valves:

1. The refrigerant connections must be of the braze type.
2. Multiple indoor units may be connected to a branch selector box / branch circuit controller.

D. Condensate Removal:

1. Provide integral condensate pan if required for condensate removal.

E. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 228 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum
4. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.04 INDOOR FAN COIL UNITS

A. Non-Ducted Recessed Ceiling Cassette Units

1. General: Indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, white, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The indoor units sound pressure shall range from 28 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.
2. Indoor Unit:
 - a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - c. Both refrigerant lines shall be insulated from the outdoor unit.
 - d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
 - e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
 - f. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
 - g. The indoor units shall be equipped with a return air thermistor.

3. Unit Cabinet:
 - a. The cabinet shall be space saving and shall be located into the ceiling.
 - b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
 - c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
 - d. Fresh air intake shall be possible by way of optional fresh air intake kit. (3'x 3' model only). Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet. (2'x 2' model only')
 - e. A branch duct knockout shall exist for branch ducting supply air.
 - f. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
 - g. Optional high efficiency MERV 8 and 13 air filters are available for each model unit. (3'x 3' model only)
4. Fan:
 - a. The fan shall be direct-drive fan type with statically and dynamically balanced impeller with high and low fan speeds available.
 - b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
 - c. The airflow rate shall be available in high and low settings.
 - d. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the MERV 8 and 13 filter options (3'x 3' model only).
 - e. The fan motor shall be thermally protected.
5. Filter:
 - a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
 - b. Optional high efficiency disposable MERV 8 and 13 filters shall be available. (3'x 3' model only)
6. Coil:
 - a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - c. The coil shall be a 2-row cross fin copper evaporator coil completely factory tested.
 - d. The refrigerant connections shall be flare connections.
 - e. A condensate pan shall be located under the coil.
 - f. A condensate pump, with minimum 21-inch lift, shall be located below the coil in the condensate pan with a built in safety alarm.
 - g. A thermistor will be located on the liquid and gas line.
7. Electrical:

- a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
8. Control:
- a. The unit shall have on board controls to perform input functions necessary to operate the system.
 - b. The unit shall include all devices necessary to be compatible with interfacing with a BAS system via optional LonWorks or BACnet gateways.
9. Optional Accessories Available:
- a. A high efficiency disposable MERV 8 air filter kit. (3' x 3')
 - b. A high efficiency disposable MERV 13 air filter kit. (3' x 3')
 - c. Fresh air intake kit.
 - d. Supply air branch duct connections.
 - e. Remote "in-room" sensor kit.
 - f. The wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

B. Ducted Concealed Ceiling Fan Coil Units

1. General:
 - a. Indoor unit shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation in a ceiling cavity. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Included as standard equipment, a condensate drain pan and drain pump kit that pumps up to 18-3/8" from the drain pipe opening.
 - b. All pressure drops, horsepowers and dimensions shown on drawing schedules are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
 - c. Manufacturers unable to meet these criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
2. Sound Pressure Level:
 - a. Large capacity, medium static units: 48 dB(A) at low speed measured 5 feet below the ducted unit.
 - b. Small capacity, medium static units: 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.

- c. Shallow depth fan coils: 29 dB(A) to 32 dB(A) at low speed and 33 dB(A) to 36 dB(A) at high speed 5 feet below the suction grille.
3. Indoor Unit: The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch (Large models). The unit shall be equipped with automatically adjusting external static pressure logic selectable during commissioning. This adjusts the airflow based on the installed external static pressure. (Small models)
 - a. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - b. Both refrigerant lines shall be insulated from the outdoor unit.
 - c. The indoor units shall be equipped with a return air thermistor.
 - d. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet (Small and slim model only)
 - e. Return air shall be through a resin net mold resistant filter (slim model only)
4. Unit Cabinet:
 - a. The cabinet shall be located within the ceiling and ducted to the supply and return openings.
 - b. The cabinet shall be constructed with minimum 1/2" 1.5 lbs. internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion or of an insulation type not requiring protection.
5. Fan:
 - a. (Large models and slim duct):
 - 1) The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
 - 2) The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz, with a motor output of 0.51 HP.
 - 3) The airflow rate shall be available in high and low settings.
 - 4) The fan motor shall be thermally protected.
 - 5) The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
 - b. Fan (Small models):
 - 1) The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
 - 2) The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
 - 3) The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
 - 4) The airflow rate shall be available in three settings.
 - 5) The fan motor shall be thermally protected.

- 6) The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
 6. Coil:
 - a. Coils shall be ARI certified of the direct expansion type.
 - b. All coil casings shall be galvanized steel minimum or stainless steel.
 - c. Copper tubes shall be a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond.
 - d. The coils shall be pressure tested at the factory.
 - e. The refrigerant connections shall be flare connections.
 - f. A thermistor will be located on the liquid and gas line.
 - g. A condensate pan shall be located under the coil
 - h. The condensate shall be capable of being gravity drained from the fan coil.
 - i. Where scheduled, a condensate pump with an 18" minimum lift shall be located below the coil in the condensate pan with a built in safety alarm.
 7. Electrical:
 - a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
 8. Control:
 - a. The unit shall have on board controls to perform input functions necessary to operate the system.
 - b. The unit shall include all devices necessary to be compatible with interfacing with a BAS system via optional LonWorks or BACnet gateways.
 9. Optional Accessories Available:
 - a. Remote "in-room" sensor kit (recommended).
 - b. The wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).
- C. Non-Ducted Wall or Ceiling Fan Coil Units
1. General: Indoor unit shall be a fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall or ceiling within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition.
 2. Condensate drain pan:
 - a. Ceiling Suspended Cassette Unit: A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.

- b. Wall Mounted Unit: A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.
 - c. Floor Console Unit: A mold-resistant, resin net air filter shall be included as standard equipment.
3. Sound Pressure:
- a. Ceiling Suspended Cassette Unit: The indoor units sound pressure shall range from 32 dB(A) to 38 dB(A) at low speed measured at 3.3 feet below and from the unit.
 - b. Wall Mounted Unit: The indoor units sound pressure shall range from 31 dB(A) to 40 dB(A) at low speed measured at 3.3 feet below and from the unit.
 - c. Floor Console Units (Surface mount and concealed types): The indoor units sound pressure shall range from 35 dB(A) to 40 dB(A) at high speed measured at 5 feet away and 5 feet high.
4. Indoor Unit:
- a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops
 - b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - c. Both refrigerant lines shall be insulated from the outdoor unit.
 - d. Return air shall be through a resin net mold resistant filter.
 - e. The indoor units shall be equipped with a condensate pan.
 - f. The indoor units shall be equipped with a return air thermistor.
5. Unit Cabinet:
- a. The cabinet shall be affixed to a factory supplied wall/ceiling hanging brackets and located in the conditioned space.
 - b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
6. Fan:
- a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
 - b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz.
 - c. The airflow rate shall be available in high and low settings.
 - d. The fan motor shall be thermally protected.
7. Filter:
- a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin (Floor console only).
8. Coil:
- a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

- b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - c. The coil shall be a 2-row (3-row floor console only) cross fin copper evaporator coil completely factory tested.
 - d. The refrigerant connections shall be flare connections.
 - e. A thermistor will be located on the liquid and gas line.
 - f. A condensate pan shall be located in the unit.
9. Electrical:
- a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
10. Control:
- a. The unit shall have on board controls perform input functions necessary to operate the system.
 - b. The unit shall include all devices necessary to be compatible with interfacing with a BAS system via optional LonWorks or BACnet gateways.
11. Optional Accessories Available:
- a. Remote "in-room" sensor kit.
 - b. A condensate pump.

2.05 CONTROLS

A. General:

1. Provide control devices necessary to support a fully operating system including but not limited to
 - a. Local remote controllers,
 - b. Centralized/multi-zone controllers,
 - c. Open protocol network devices that transmit information via the communication bus and graphical user workstations.
2. The network shall have the capability to support
 - a. Operation monitoring and scheduling,
 - b. Error email distribution
 - c. General user software, tenant billing, maintenance support, and integration with Building Automation Systems (BAS) using open protocol via BACnet or Lonworks interfaces.

3. General Electrical Requirements: The control wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to the branch circuit selector/controller (Heat Recovery System), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. Wiring shall be non-shielded, 2-conductor sheathed vinyl core or cable, AWG stranded copper wire installed per manufacturer's written instructions.

B. Local Remote Controllers

1. The local remote controllers shall be capable of controlling up to 16 indoor units (referred to as a group). The local remote controllers shall maintain the optimal operation of the connected indoor units. Local remote controllers consist of deluxe, simplified and wireless models. No more than two of these controllers can be placed in the same group. No addressing shall be required with the local remote controllers.
2. Basic Operation: Local remote controller shall control the following group of operations:
 - a. On/off, operation mode (cool, heat, fan, dry and Auto)
 - b. Independent cooling and heating setpoints in the occupied mode
 - c. Independent cooling setup and heating setback setpoint in the unoccupied mode.
 - d. Fan speed
 - e. Airflow direction
 - f. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
 - g. Function key lockout
3. Programmability:
 - a. Controller shall support 7-day programmable scheduling,
 - b. The controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoors unit's mode between cool and heat according to the room temperature and temperature setpoint.
 - c. The controller shall support an auto off timer for temporarily enabling indoor unit operation using unoccupied period.
 - d. The room temperature shall be capable of being sensed at either, the remote controller, the indoor unit return air temperature sensor (default), or a remote temperature sensor.
4. Display Features
 - a. LED display
 - b. The controller shall display Operations Mode, Setpoint, and Fan Speed.
 - c. System Status icons in large font.
 - d. Room temperature display
 - e. On/Off status
 - f. Error codes displayed in the event of a system abnormality/error
 - g. Optional: The following system temperatures can be displayed to assist service personnel in troubleshooting:
 - 1) Return air temperature

- 2) Liquid line temperature
- 3) Gas line Temperature
- 4) Discharge Air Temperature (depending on fan coil)
- 5) Temperature used for indoor unit control.

C. Centralized/Multizone Controllers

- a. The Centralized/Multizone controllers shall be capable of controlling up to 64 indoor unit groups and 128 indoor units connected to up to 10 outdoor units. The Centralized/Multizone Controllers shall be complete with power supply. The Centralized/Multizone Controllers can be used in conjunction with local remote controllers, BACnet and Lonworks interfaces to control the same indoor unit groups. Centralized/Multizone controllers shall be available with the option of interconnection with a network PC via the internet or Local Area Network (LAN).
 - b. Basic Operation: The Centralized/Multizone controller shall control the following group operations:
 - 1) On/off, operation mode (cool, heat, fan, dry and Auto)
 - 2) Independent cooling and heating setpoints in the occupied mode
 - 3) Independent cooling setup and heating setback setpoint in the unoccupied mode.
 - 4) Fan speed
 - 5) Airflow direction
 - 6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
 - 7) Remote controller permit/prohibit of ON/Off, Mode, and Setpoint.
 - 8) Lockout setting for touch display.
 - 9) Indoor unit Group/Zone assignment.
2. Programmability:
- a. Controller shall support weekly schedule settings.
 - b. Scheduling shall support unit On/Off.
 - c. The controller shall support multiple auto-changeover methods for both Heat Pump and Heat Recovery systems based upon the Zone configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoors unit's mode between cool and heat according to the room temperature and temperature setpoint.
 - d. Controller shall support Interlock for use with 3rd party equipment to automatically control groups or zones corresponding to the change of the operation states or On/Off states of any group.
 - e. Optional Digital Input/Output unit shall be available to allow On/Off based monitoring and control of 3rd party equipment.
 - f. The controller shall support force shutdown of associated indoor unit.
3. Display Features:
- a. Backlit LCD display.
 - b. Multi-language availability.

- c. The controller shall display On/Off, Operations Mode, Setpoint, space Temperature, Louver Position, Fan Speed for Group/Zone.
 - d. Date, day of week and time of day.
 - e. Daylight savings automatic adjustment.
 - f. Display update every 3 seconds.
 - g. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Set Schedule/Setback/Auto-changeover, Filter, and Screen Lock.
 - h. The controller shall display the temperature setpoint in one degree increments.
 - i. Zone configuration shall display Setpoint Range Limitation, Setback Temperature setting, and Auto-changeover for each Zone.
 - j. Indoor units shall be capable of being displayed by Zone or Group.
 - k. Error status shall be displayed in the event of system abnormality/error with one of two color coded icons placed over the indoor unit icon.
4. Software Options: All PC's shall be field supplied
 - a. Web/Email software: Each Controller shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (128 indoor unit groups with the addition of an option adapter) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 3 email addresses).
 - b. Power Proportional Distribution (PPD): The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the outdoor unit(s) divided among the associated indoor units. This software is used in conjunction with the Watt Hour Meter (WHM). A maximum of 3 Watt Hour Meters can be connected to the Controller. The use of the optional adapter will add an additional 3 Watt Hour Meters.
 - c. HTTP Interface: This option shall be capable of creating a software interface between the VRV Controls Network and Home Automation control systems.
- D. System BAS Integration
1. The VRV/VRF system shall support integration with Building Management Systems (BAS) via a BACnet® or LonWorks interface.
 2. BAS to have capability to monitor and control of VRV indoor units.
 3. The VRV/VRF systems supplier shall cooperate fully with BAS supplier to enable them to map points into the BAS.
 4. The BAS supplier shall provide all labor and programming necessary to map VRF system points into BAS. At a minimum, through the BAS, the operator shall be enabled to monitor space temperature of all zones change space temperature setpoint of all zones, monitor fan, heating and cooling status of all zones, monitor indoor fan coil alarm, monitor status and alarms of outdoor units and schedule each zone.
 5. Operation and monitoring points include but are not limited to:
 - a. On/Off (setting)
 - b. On/Off (status)
 - c. Alarm Sign

- d. Error Code
- e. Operation Mode (setting)
- f. Operation Mode (status)
- g. Fan Speed (setting)
- h. Fan Speed (status)
- i. Measured Room Temperature
- j. Set Room Temperature
- k. Filter Limit Sign
- l. Filter Limit sign reset
- m. Remote Control Operation (On/Off)
- n. Remote control Operation (Operation Mode).
- o. Remote Control Operation (Set Temperature)
- p. Electrical Total Power
- q. Communication Status
- r. System Forced Off
- s. Forced Thermostat off (setting)
- t. Forced Thermostat off (status)
- u. Compressor Status
- v. Indoor Fan Status
- w. Heater operation Status

2.06 REFRIGERANT GAS MONITOR

- A. Where indicated on drawings provide a standalone refrigerant gas monitor and sensor to monitor and alarm for refrigerant gas leaks in the space.
- B. Sensor to be coordinated with the refrigerant used in the VRF or VRV system and mounted remotely from unit at the level of the floor in the indicated space.
- C. Alarm to be a red LED and siren with mute button. Relays are to be provided for remote monitoring or control.

2.07 ISOLATION VALVE

- A. Bi-directional full-port full-flow manual service valve with refrigerant Schrader valve.
- B. Brass body with flared extended copper tails for brazing. Indicator on stem shows valve position-open or closed with quarter-turn of the valve stem. Blow-out proof stem design with cap seal and solid cap.
- C. Operating pressure: 0 to 700 psig (4.8 MPa/48 bar).
- D. Temperature range: -40°F to 300°F (-40°C to 150°C).
- E. Manufacturers: Henry Group #937613, Wilspec #Frontline Series, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive work.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.
- C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
- E. Provide 4" high concrete pad extending 6" beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.
- F. Install 2" flexible duct connection at inlets and outlets of ducted units.
- G. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings. Where drainage to gravity waste is not possible provide condensate pumps.
 - 1. Install manufacturer provided condensate "air-trap" where provided with each unit. Install trap per manufacturer's instructions and install condensate piping as required by local code.
- H. Install copper refrigerant piping and insulate lines.
- I. Install branch isolation valve at each fan coil and branch refrigerant selector to allow for future maintenance refrigerant recovery without the need to recover entire system charge. Valves must be full port with Schrader valve on the fan coil or branch selector side of valve. Provide quantity of valves as required to provide complete isolation of each unit. Each fan coil will require a minimum of two valves for each circuit and each branch selector may require a minimum of three valves for each circuit, and as required to serve the quantity of refrigerant circuits. Coordinate with manufacturer's installation instructions for placement of valves for full isolation and to avoid warranty violation.
- J. Control wiring: Communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector/controller (Heat Recovery system), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit. Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, AWG stranded copper installed per manufacturer's written directions.
- K. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

- L. Install a new set of air filters prior to final air balance and substantial completion.
- M. Provide support to BAS supplier for mapping of VRV/VRF systems points into the BAS.

3.03 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

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SECTION 23 82 19

FAN COIL UNITS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein. Division 01 shall not be included in these standards and shall be included as part of each projects contractual documentation as required.

1.02 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
 - 1. Fan Coils.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic HVAC Materials and Methods.
- B. Section 230593: Testing, Adjusting and Balancing.
- C. Section 230900: Building Automation System (BAS) Controls.
- D. Section 230716: Equipment Insulation.
- E. Section 232113: Hydronic Piping, Valves and Specialties.
- F. Section 233113: Air Distribution.
- G. Division 26: Electrical.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
- C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
 - 1. Air Movement and Control Association (AMCA)/American National Standards Institute (ANSI):
 - a. 99: Standards Handbook.
 - b. 210: Laboratory Methods of Testing Fans

- c. 230: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification
 - d. 300: Reverberant Room Method for Sound Testing of Fans
 - e. 301: Methods for Calculating Fan Sound Ratings from Laboratory Test Data
 - f. 500-D: Laboratory Methods of Testing Dampers for Rating
2. American National Standards Institute (ANSI)/Anti-Friction Bearing Manufacturers Association (ABMA):
 - a. 9: Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11: Load Ratings and Fatigue Life for Roller Bearings.
 - c. 900: Test Performance of Air Filter Units.
 3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - a. 410: Forced-Circulation Air-Cooling and Air-Heating Coils.
 - b. 430: Central-Station Air-Handling Units.
 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 193: Method of Test for Determining the Air Tightness of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
 5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 6. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
 7. ANSI/AHRI-850: Performance Rating of Commercial and Industrial Air Filter Equipment.
 8. Underwriters Laboratories, Inc. (UL), Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL:
 - a. 900: Standard for Air Filter Units.
 9. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
 - a. 70 - National Electrical Code.
 - b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.

- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.08 WARRANTY

- A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
- B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 PRODUCTS

2.01 FAN COIL UNIT – FOR COMMERCIAL APPLICATION

- A. Manufacturers:
 - 1. Enviro-Tec, Carrier, Trane, Energy Labs, or equal.
- B. General:
 - 1. Factory fabricated fan coil units of the size, type configuration and capacity as scheduled on the drawings.
 - 2. All pressure drops, motor horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
 - 3. Manufacturers unable to meet these criteria will only be considered as an alternate to the specified unit and as a deduct to the base bid. Manufacturer listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
- C. Unit Casing:
 - 1. Unit shall be constructed of no less than 16 gauge formed cold-rolled steel with minimum 1" 1.5 lb. density internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion. All exposed metal inside and out shall be finished with at least one coat of gray enamel. Bottom access doors shall be aluminum construction 0.063 thickness painted to match unit.
- D. Fan Assembly:

1. Bearings shall be ball or roller type. Sleeve bearings are not acceptable. Bearings shall have replaceable inserts so entire housing need not be replaced. Bearings shall be self-aligning to assist in shaft alignment. Self-locking collars shall be provided to secure bearing to the shaft. Bearing housing shall be cast iron for strength and long life. Each bearing shall have pressure relief fittings to assure bearing seal life. Bearing life shall be minimum L-10 100,000 hour. Calculations shall be made on the basis of load ratings based on the AFBMA "Method of evaluating load ratings for ball bearings", and are the steady, radial loads that bearings can endure at various speeds for 1,500 hours with 90% of the group surviving. Calculations shall be submitted for engineer review upon request. Bearing operation shall be checked under load at the design speed. Bearing pass/fail criteria shall be based on 1987 ASHRAE Handbook, chapter 52, table 26.
2. Rotating assembly shall be steel channel type construction to provide rigid support for motor, drive, bearings, shaft and wheel. Entire assembly to be mounted on open coil type springs with seismic restraint. Assembly shall have bottom access and entire assembly shall swing down for maintenance. Assembly shall also be completely removable without disassembling unit casing.
3. Shafting shall be carbon steel, turned, ground and polished to close tolerance and oversized to insure vibration free operation. Shafts shall be selected not to exceed 75% of first critical speed. Shaft shall be cleaned and coated to protect against condensation and/or airborne contamination. The cleaning procedure shall include removing any surface rust, loose mill scale, weld spattering and sharp prominences by scraping, sanding and wire brushing to the degree specified by SSPC-SP-1 & 2. The removal of all oil, grease, dirt, salts, soil and contaminants shall be accomplished by cleaning with solvent. After cleaning, shaft shall be coated all over exposed surfaces with a lacquer based shaft protectant. Bluing pigment shall be added to facilitate visual conformation of total coverage. Removal of coating for wheel and hub service shall be achieved with the use of only a lacquer thinner.
4. Fans may be direct drive or belt drive as shown on the drawings. Belt drive units shall utilize a V-belt with cast iron sheaves. Motor sheaves shall be of the adjustable pitch diameter type. Drives shall be rated at no less than 150% of nameplate horsepower.
5. Motors shall be standard NEMA frame type. All motors shall be premium efficiency type. No others are acceptable.
6. Fractional horsepower motors to be resilient mounted and integral horsepower motors to be rigid mounted to spring isolated rotating assembly frame. Power leads from motors to be field installed with flex connection to field supplied junction box allowing enough length for rotating assembly swing down.

E. Coils:

1. Coils shall be ARI certified and of the same manufacturer as the unit to insure proper fit and quality. All coil casings shall be 16-gauge galvanized steel minimum or stainless steel. Copper tubes shall be minimum 5/8" diameter with a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond. No exposed copper shall show between fins.
2. Coils shall be mounted in stainless steel drain pans.

F. Filter Section:

1. Filters shall be minimum MERV-13 efficiency and velocity shall be less than 500 FPM.
2. Filter access is bottom removal unless shown otherwise on plans and schedule.

- G. Unit Suspension:
1. Manufacturer to provide factory welded mounting clips for suspension of units. Clips to be capable of accepting 1/2" rod or isolators. Weights shown on plans are maximum allowable operating weights including water in coils.
- H. Side Access:
1. Where shown on plans provide side access to unit components. Access panel is to be hinged and large enough to provide full access to internal components. Door latch to be CAD plated spring steel manual quick release "Ludwig" latch with pressure closure mechanism. Door to be painted galvanized 16-gauge steel with pin break edge reinforcement. Door to be sealed on all four edges with gasket adhesively attached to the door panel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Examine site to verify if site is ready to receive work. Provide a layout drawing of fan locations to electrical installer.
- C. Install minimum MERV-13 efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. Install unit supported by vibration isolation springs.
- E. Install 3" flexible duct connection at inlets and outlets of units.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
1. Install manufacturer provided condensate "air-trap" where provided with each unit. Install trap per manufacturer's instructions and install condensate piping as required by local code.
- G. Provide and install condensate pump as required and as shown on the Drawings. Coordinate with plumbing design and electrical design as necessary.
- H. Control installers shall install all control conduit and wiring associated with control functions required as shown on the drawings.
- I. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- J. Install a new set of filters prior to final air balance. If these filters become dirty due to ongoing construction or fans were operational for more than thirty days following the final air balance, provide and install an additional new set of filters prior to Certificate of Occupancy. The Owner's Representative shall determine if filters are acceptable.

3.02 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours of travel from the job site.

END OF SECTION

DIVISION 25

INTEGRATED AUTOMATION

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SECTION 25 05 00
INTEGRATED AUTOMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, apply to this Section, except as specifically noted in this Section.
- B. Product and installation requirements for electrical, communications, and building automation wiring and devices in Division 23, Division 26, and Division 27 apply to this Section, except as specifically noted in this document.
- C. Related Specifications
 - 1. Division 23
 - 2. Division 26
 - 3. Division 27

1.2 SUMMARY

- A. This specification section is merely a starting point to provide the Designer and/or Design Build Entity a high-level requirement for the Integration Automation and Direct Digital Controls (DDC) systems required by the District. It is the responsibility of the Designer to develop detailed specifications for Division 25 and related divisions as a part of the design process inclusive of hardware components, sequence of operations, submittals, applicable testing procedures, and other typical specification sections. As part of the Work performed under Division 25 "Integrated Automation", the DDC Contractor shall furnish control devices, instruments, meters, and sensors in accordance with this Section and Division 23. Provide all control devices, instruments, meters, and sensors required for a fully functional DDC System capable of fully executing the specified Sequences of Operations
- B. All networked control devices shall be ANSI/ASHRAE 135 native BACnet devices.
 - 1. All DDC devices shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL) prior to the bid date for this Project.
 - 2. The BACnet operating stack must be embedded directly in each individual DDC device at the media access controller level and in all operator interface and configuration applications.
 - 3. Communication gateways, bridges, and protocol translators are permitted only under the following conditions:
 - a. Protocol translators as required to communicate to existing building systems or legacy control systems.
 - b. Equipment-specific gateways and dedicated controllers that are supplied, recommended or endorsed by the manufacturer of the equipment they are to control.
 - c. Gateways shall allow the DDC System to read all readable object properties and write to all writeable object properties using standard BACnet services.
 - d. Gateways shall provide all BACnet communication services and features described in "BACnet Gateways" under Network Communication Devices in Part 2 of Section 25 50 00

- C. DDC System shall monitor and/or control the following systems:
1. HVAC Systems
 2. Plumbing Systems
 3. Lighting Control Systems
 4. Power Metering Systems
- D. The DDC System shall have the future capability to monitor and/or control the following systems:
1. Fire Alarm
 2. Access Control
 3. Video Surveillance
 4. Power Management
 5. Photovoltaic Systems

1.3 CODES AND STANDARDS

- A. Workmanship, materials, and equipment together with the resultant complete and operational DDC System shall be in compliance with the Authorities Having Jurisdiction (AHJ) for the project and the most restrictive of applicable local, state, and federal codes and ordinances in cooperation with these plans and specifications.
- B. At a minimum, the installation shall comply with the applicable sections of the current editions in effect thirty (30) days prior to receipt of bids of the following codes:
1. ANSI/ASHRAE Standard 135: Data Communication Protocol for Building Automation and Control Networks (BACnet)
 2. Building Industry Consulting Services International (BICSI): Telecommunications Distribution Methods Manual (TDMM)
 3. Title 24 Part 6: California Energy Code
 4. International Building Code (IBC), for Projects outside of California
 5. International Mechanical Code (IMC), for Projects outside of California
 6. National Electric Code (NEC) with all state and local amendments
 7. Telecommunications Industry Association (TIA):
 - a. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises
 - b. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standards
 - c. ANSI/TIA-568-C.2: Balanced Twisted Pair Telecommunications Cabling and Components
 - d. ANSI-TIA-607-B: Generic Telecommunications Bonding and Grounding for Customer Premises

1.4 QUALIFICATIONS AND QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
1. Nationally recognized manufacturer of DDC systems
 2. Has produced DDC systems with similar requirements to those specified for a continuous period of five years within time of bid.

3. Has produced DDC systems and products that have been successfully tested and in use on at least ten past Projects of comparative size and complexity.
 4. Has complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
 5. Has full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing and quality control.
 - d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
 - e. Owner operator training.
 6. All products used in this installation shall be new and currently under manufacture. Spare parts shall be available for at least five years after completion of this contract.
 7. All products shall have been available from the manufacturer for a minimum of 6 months prior to date of proposal and previously installed and proven effective in installations of similar nature, not including test sites. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing.
 8. All BACnet devices must either be certified as compliant with the BACnet standard through a listing by the BACnet Testing Laboratory (BTL) or the vendor must supply proof of having submitted the device for testing by BTL.
 9. The DDC system and components shall be listed by Underwriters Laboratories UL 916 as an Energy Management System.
 10. Manufacturer shall be ISO 9001 registered.
- B. DDC Contractor Qualifications:
1. Authorized representative of, and trained by, the specified DDC System manufacturer.
 2. Contractor's Project Manager Qualifications: Individual shall specialize in and be experienced with direct digital control system installation for not less than 3 years. Project Manager shall have experience with the installation of the proposed direct digital control equipment product line for not less than 2 Projects of similar size and complexity.
 3. Contractor's Programmer Qualifications: Individual(s) shall specialize in and be experienced with direct digital control system programming for not less than 3 years and with the proposed direct digital control equipment product line for not less than 1.5 years. Programmers must show proof of having successfully completed the most advanced programming training offered by the vendor of the programming application on the proposed product line.
 4. Contractor's Service Qualifications: The installer must be experienced in control system operation, maintenance, and service. Contractor must document a minimum 5-year history of servicing installations of similar size and complexity. Installer must also document at least a 1-year history of servicing the proposed product line.
 5. Contractor's Response Time and Proximity
 - a. Installer must maintain a fully capable service facility within 50 miles of the subject Project. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
 - b. Installer must demonstrate the ability to meet the emergency response times listed.
 6. Electrical installation shall be by manufacturer-trained electricians
 - a. Exception: Roughing in wiring and conduit and mounting panels may be subcontracted to any licensed electrician.
 - b. Exception: Installation of low voltage power and signal wiring may be performed

by contractors who are not licensed electricians, if permitted by local code, the General Contractor, and the AHJ.

7. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
8. Service and maintenance staff assigned to support Project during warranty period.
9. Product parts inventory to support on-going DDC system operation for a period of not less than five years after completion of Work.

PART 2 – PRODUCTS

- A. Global Controller – Tridium Niagara Platform, JACE 9000 Compliant
- B. Field Controllers –
 1. ABB Controls
 2. Honeywell CIPer
 3. Johnson Controls FX
 4. ALC (LAVC campus only)
- C. The Tridium Niagara platform is to be used for all buildings at all Colleges and shall be open license. Station Compatibility In/Out and Tool Compatibility In/Out shall be “All.” No compatibility restrictions are acceptable.
- D. Operator Workstation – The DDC systems shall be set up on a virtual network and as such a dedicated operator workstation is not required.

PART 3 – SYSTEM ARCHITECTURE

- A. General
 1. The system shall be configured as a distributed processing internetwork capable of expansion as specified herein.
 2. All control products provided for this Project shall comprise an interoperable Native BACnet System. All control products provided for this Project shall conform to ASHRAE Standard 135.
 3. Provide hardware and software resources sufficient to meet the functional requirements specified in this Section. Include all items not specifically described in this Section that are necessary to implement, maintain, and operate the system in compliance with the functional intent of this Specification.
- B. Networking Requirements
 1. The DDC internetwork shall be open and non-proprietary, and available to other companies for use in making future modifications to DDC system.
 2. The ASHRAE 135 BACnet communication protocol shall be sole and native networking protocol used throughout the entire DDC system. Only native BACnet control devices shall be used without explicit written permission by the Engineer of Record.
 3. Communication gateways, bridges, protocol translators or any other device that translates any proprietary communication protocol to BACnet are not acceptable as a part of the Work under this Section, with specific exceptions.

4. DDC System shall communicate via a dedicated control internetwork that is not shared with other building systems or tenant data and communication networks.
 - a. The Owner's IT network shall not be used for control purposes.
 - 1) Exception: Supervisory Network may utilize existing Wide Area Network (WAN) if DDC System spans multiple buildings, with permission of Owner.
 - b. If permitted by Owners, control internetwork may share router hardware and physical network infrastructure if there is sufficient capacity. Control internetwork must be logically separated from IT network (e.g. by vLAN).
 - c. Any use of Owner's IT infrastructure requires written permission from Owner. DDC Contractor shall coordinate with Owner and Owner's IT staff.
5. DDC System as provided under this Section shall implement the following BACnet data links only:
 - a. BACnet/IP
 - b. BACnet Master-Slave/Token-Passing (MS/TP)
 - 1) MS/TP network backbone speeds shall be 76,800 bps if possible, and no less than 38,400 bps in any case.
 - 2) Speeds of 9,600 bps or 19,200 bps shall be permitted to connect with specific devices that cannot support higher speeds.
 - 3) No other speeds shall be acceptable.
 - c. Point-to-Point (PTP), for dial-up access, only if required.
 - d. BACnet Ethernet (ISO 8802.3).
 - e. All other BACnet data links shall be excluded from this Project. Other non-BACnet data links and protocols such as TCP/IP, SMTP, and HTTP, are permitted as required elsewhere in this Section.
6. MS/TP networks are limited as follows:
 - a. No single MS/TP network shall exceed a wire run length of 2,000 feet.
 - b. Repeaters/amplifiers shall not be used.
 - c. Only MS/TP Master devices are permitted. MS/TP slave devices shall not be used.
 - d. No single MS/TP network shall exceed 32 full-load nodes.
 - 1) For the purposes of this Specification, any devices that do not support both the Read Property Multiple (RPM) service and Data Segmentation for both Transmit and Receive, shall be considered full-load nodes.
 - e. No single MS/TP network shall exceed 64 devices total, regardless of load level.
7. Irrespective of other network connectivity requirements or lack thereof, the DDC System shall be configured such that devices supporting MS/TP can send (but not receive) email over the public internet. This capability shall be used to notify operators of events and alarms as detailed elsewhere in this Section.
8. Wireless communication in any control LAN is not acceptable without review and approval by the LACCD Facilities, Planning, and Development department. DDC Contractors who wish to use wireless devices or networking are required to use the pre-submittal

process for approval.

- C. Network Architecture: The DDC network shall consist of no more than three levels of networks.
1. A Supervisory Control Network may be used to connect building controllers, servers, and operator workstations.
 - a. Supervisory Network may be a Local Area Network, or it may span multiple buildings or locations as a Wide Area Network (WAN).
 - b. Supervisory Network link layer shall be Ethernet (IEEE802.3).
 - c. Supervisory Network networking layer shall be BACnet/IP and shall share a common network number for the Ethernet backbone, as defined in ASHRAE Standard 135.
 - d. Supervisory Network, including all routers and switches, shall support no less than 100 Mbps.
 - e. Powerline communications is not acceptable.
 2. A Primary Control LAN shall connect advanced application controllers to building controllers and to other advanced application controllers. The Primary LAN communicates exclusively with control information.
 - a. Each Primary LAN shall be contained within a single building. A single Primary LAN shall not span multiple buildings.
 - b. Primary LAN link layer shall be Ethernet (IEEE802.3) or MS/TP.
 - c. Primary LAN networking layer shall be BACnet/IP, BACnetEthernet, or MS/TP as defined in ASHRAE Standard 135.
 - d. If a Primary LAN communications trunk is severed, the network shall reconfigure itself into separate LANs and continue operations without interruption or requiring operator intervention.
 - e. Primary LAN, including all routers and switches, shall support no less than 100 Mbps.
 - f. Powerline communications is not acceptable.
 3. Secondary Control LANs shall connect application specific controllers to other application specific controllers and to terminal control devices such as networked thermostats. Each Secondary Control LAN shall connect to a Primary Control LAN via a BACnet router, or via an advanced application controller or building controller.
 - a. Each Secondary LAN shall be contained within a single building. A single Secondary LAN shall not span multiple buildings.
 - b. Secondary LAN link layer shall be Ethernet (IEEE802.3) or MS/TP.
 - c. Secondary LAN networking layer shall be BACnet/IP or BACnet MS/TP as defined in ASHRAE Standard 135.
 - d. Secondary LAN speed and bandwidth shall be dictated by the number of controllers on the LAN, response time and trending requirements, but shall be no less than 38.4 kbps (BACnet MS/TP) or 10 Mbps (BACnet/IP).
 4. The network architecture, and number and type of LANs shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all DDC System networks.
 5. To the extent feasible, Secondary Control LANs shall be configured so that the control network architecture parallels the mechanical system architecture. For example, a Secondary LAN of VAV controllers should connect directly to the advanced application controller or building controller which controls the air handler that serves the VAV boxes.

D. System Software

1. DDC System Software shall include a BTL-listed BACnet Advanced Workstation (B-AWS) that supports full-featured supervision, configuration, programming, and control of the DDC System. See Paragraph 2.4C.
 - a. DDC Contractor shall configure laptops, desktops and servers running B-AWS software to connect to the control internetwork. Portable devices running B-AWS shall be able to connect at any Ethernet port on the control internetwork.
2. DDC System Software shall include an Operator's Web Interface (OWI) that supports complete supervisory access to DDC system and limited control functions via a web browser, without additional software requirements. See Paragraph 2.4B.
3. DDC System Software may include applications to store, manage, retrieve and/or analyze long-term trend data, if required in Article 2.4.
4. All actions shall be performed over the DDC System internetwork. Systems that require direct connection to DDC field devices or controllers for any of these services are not acceptable.
5. All System Software shall be provided and licensed to the Owner per Paragraphs 1.3B.2 and 1.10B.

PART 4 – TRAINING

- A. Coordinate schedule and materials with Owner and Commissioning Authority.
- B. Provide preliminary training as required such that operating staff can respond to occupant needs and other operating requirements during start-up and commissioning phase.
- C. Formal Training
 1. Training shall be conducted after all commissioning is complete and the systems are fully operational. Training shall not start until Functional Testing is complete and the Functional Test Report has been submitted and accepted.
 2. Provide training sessions for personnel as required by Owner.
 3. Training Schedule
 - a. Schedule training to provide Owner with at least 10 business days advance notice.
 - b. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays.
 - c. Training shall be scheduled within 30 days of the completion (including acceptance) of Functional testing, unless otherwise authorized by the Owner.
 - d. All training sessions shall occur within a four-week period.
 - e. Each complete training session shall occur on a different day, to facilitate maximum attendance. Schedule training sessions as required to accommodate Owner's needs.
 4. Attendance Tracking
 - a. Request from Owner in advance of training a proposed

- attendee list with name, phone number and e-mail address.
- b. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and blank spaces to add additional attendees. Participant tracking can also be performed electronically.
 - 1) Include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session.
 - 2) List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
 - c. Circulate sign-in sheet at beginning of each session and solicit attendees to sign/initial.
 - d. At end of each training day, send Owner and Commissioning Authority e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet or equivalent digital participant record for each session.
5. Off-Site Primary System Training
- a. Primary training on DDC System functions and operations shall be provided off-site by the DDC Manufacturer's training staff, either at the factory or at a permanent training facility.
 - b. Primary training by DDC Contractor staff is not acceptable.
 - c. The length of each training period will depend on the complexity of the system and the audience. Minimum training time shall be 24 hours, but the period shall be longer if required to complete the training tasks described herein.
 - d. Expenses for transportation to and from the training facility, hotel, and meals shall be provided by the Owner and excluded from the DDC System bid. Cost for books, manuals and any other type of training equipment or material shall be included in the DDC System bid.
 - e. The training shall accommodate up to 12 District personnel.
6. On-Site Training
- a. Include an additional 40 hours total of on-site training to assist personnel in becoming familiar with site-specific issues, systems, Sequences of Operations, etc.
 - b. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
 - c. Instructor shall provide training materials, Projector and other audiovisual equipment used in training.
 - d. Training shall be provided by factory-trained instructors experienced in presenting this material. DDC Contractor staff may provide training, if so qualified.
 - e. Training may be in non-contiguous days at the request of the Owner.
7. Training Content and Levels
- a. Operators are divided into three levels of expertise and shall receive training including but not limited to the tasks listed for each training

- level.
- b. DDC Contractor shall provide training for personnel in numbers and at levels requested by the Owner. Coordinate with Owner and Commissioning Authority.
 - 1) At a minimum plan to train 2 Regular Operators, 1 Advanced Operator, and 1 System Administrator.
 - c. Regular Operators shall be trained to perform the following tasks:
 - 1) Proficiently operate the system
 - 2) Understand control system architecture and configuration
 - 3) Understand BAS system components
 - 4) Understand system operation and Sequences of Operations
 - 5) Operate the workstation and peripherals
 - 6) Log on and off the system
 - 7) Access graphics, point reports, and logs
 - 8) Adjust and change system set points, time schedules, and holiday schedules
 - 9) Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - 10) Understand and acknowledge alarms
 - 11) Understand system drawings, and Operation and Maintenance manual
 - 12) Understand the Project layout and location of control components
 - 13) Print point and predefined reports
 - d. Advanced Operators shall be trained as Regular Operators plus the following tasks:
 - 1) Make and change graphics on the workstation
 - 2) Create, delete, and modify alarms, including annunciation and routing
 - 3) Create, delete, and modify point trend logs, and graph or print these both on an ad- hoc basis and at user-definable time intervals
 - 4) Create, delete, and modify reports
 - 5) Add, remove, and modify system's physical points
 - 6) Create, modify, and delete programming
 - 7) Add control panels
 - 8) Add Operator Workstations
 - 9) Create, delete, and modify system displays — both graphical and otherwise
 - 10) Perform BAS system field checkout procedures
 - 11) Perform BAS controller unit operation and maintenance procedures
 - 12) Perform workstation and peripheral operation and maintenance procedures
 - 13) Perform BAS system diagnostic procedures
 - 14) Configure hardware including PC boards, switches, communication, and I/O points
 - 15) Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - 16) Adjust, calibrate, and replace system components
 - 17) Maintain software and prepare backups
8. System Administrators shall be trained as Regular Operators plus the following tasks:
- a. Maintain software and prepare backups

- b. Create and print custom reports, including tenant billing summaries
 - c. Interface with Project-specific, third-party operator software
 - d. Add new users and understand password security procedures
- D. Training Materials
- 1. Provide each attendee with a color hard copy of all training materials and visual presentations.
 - 2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 - 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
 - 4. Additionally, store an electronic copy of training materials and training videos (if applicable) on Data Archive Server (if provided) and Operators Portable Workstation.
 - 5. Training materials shall include step-by-step instructions (including illustrations, screen captures, etc.) for how to perform all task identified in Paragraph 3.16D such that a new operator, who has not attended the training in person and has minimal familiarity with this DDC System, can easily follow the instructions and successfully perform all of the identified tasks.
- E. Video of Training Sessions:
- 1. Trainer shall provide or arrange for a digital video and audio recording of each training session. Create a separate recording file for each session.
 - 2. Stamp each recording file with training session number, session name and date.
 - 3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
 - 4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.
- F. During the warranty period, provide unlimited live support for all trained operators. DDC Contractor or DDC System Manufacturer shall provide a direct customer support channel for user questions and feedback, preferably as a message or chat application native to the Operator's Interface.

END OF SECTION

DIVISION 26

ELECTRICAL

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 DESIGN CRITERIA

A. CODES AND STANDARDS

B. National Electrical Code

C. California Building Code

D. California Electrical Code

1. International Building Code
2. California Building Energy Efficiency Standards (Title-24).
3. Americans with Disability Act (ADA)
4. NFPA – National Fire Protection Association
5. International Fire Code with California Amendments
6. IESNA Standards
7. UTILIZATION VOLTAGES
8. Primary Voltages 4.16KV, 3-Phase, 3-Wire
9. Secondary Voltages 480Y/277V, 3-Phase, 4-Wire
208Y/120V, 3-Phase, 4-Wire
10. Emergency/ Standby 480Y/277V, 3-Phase, 4-Wire
208Y/120V, 3-Phase, 4-Wire

1.2 BRANCH CIRCUITS

A. Special Purpose Receptacles 208V, 1-phase and 208V, 3-Phase

B. Lighting 277V

C. Special Purpose Lighting 120V

D. Motors 1/3HP and smaller 120V

E. General Use Receptacles 120V

F. Motors 1/2HP and larger 480V, 3-Phase

G. ELECTRICAL SERVICE

1. Normal Power
 - a. Each building shall be served from the campus medium voltage power distribution through a pad-mounted transformer located adjacent to the building. Incoming

service shall be rated 480Y/277V, 3-phase, 4-wire, 60 Hz. Main service feeders shall be routed underground.

- b. A load interrupter switch with current limiting fuse shall be provided at the service entrance to feed the medium voltage transformer.
- c. The medium voltage transformer shall be dry type, step down from current existing primary voltage to 480V, 3-phase, 3-wire or 277/480V, 3-phase, 4-wire.
- d. The unit substation comprising of the load interrupter switch, medium voltage transformer and the secondary disconnect circuit breaker shall be in NEMA 1 enclosure indoor type located inside the main electrical room. If there is no space for the unit substation, the load interrupter switch and the medium voltage transformer shall be in NEMA 3R enclosure located outdoor with a secondary circuit breaker disconnect. Incoming service to the building shall be fed underground in duct banks.
- e. Emergency Power
- f. The emergency generator shall be provided to provide power to the egress lighting, life safety equipment (fire alarm system, fire protection equipment), elevators, fire pumps and other selected equipment in case of normal power failure. The emergency power to a building shall be from an outdoor rated diesel generator with an enclosure rated for the exterior.
- g. The generator shall be sized to carry future loads and 20% spare capacity. The emergency generator shall consist of engine generator and controls, sound attenuation enclosure, UL listed fuel tank, exhaust system, radiator, batteries, starting system and generator output circuit breaker.
- h. Fuel storage shall be provided by base-mounted fuel tank located at the bottom of the generator. Tank size shall be enough for 24 hours of emergency operation at full load.
- i. Separate ATS switches will be provided for life safety loads, legally required loads, and optional standby loads (normal).
- j. Provide an MTS at building exterior to allow for a temporary generator to be connected to buildings that are designed with only a single emergency power source.

1.03 METERING

- A. Utility meters shall be located on the main service switchboard for standalone buildings. For campus wide power distribution metering shall be at the primary side.
- B. All LACCD Buildings including Central Utility Plant in any size structure or configuration shall have sub-meters installed.

- C. Building level sub meters shall be configured to interface and exchange data with the District's existing metering software.
- D. Building level sub meters shall include an Ethernet communication port or wireless communication capability or other networking capability.
- E. Building level sub meters shall be installed to capture the following data at a minimum of 15-minute intervals:
 - 1. Electricity consumption (kWH)
 - 2. Power demand (kW)
 - 3. Power Factor
 - 4. Natural gas consumption (therms) (if applicable)
 - 5. Building level utility sub meters may be installed to capture the following data at a minimum of 15 minute intervals:
 - a. Chilled water (if applicable)
 - b. Hot water (if applicable)
 - c. Domestic water
 - d. Sewer discharge
 - 6. Building level sub meters shall include an Ethernet communication port or wireless communication capability or other networking capability.
 - 7. Individual meters shall retain data for a period of no less than 12 months.
 - 8. Photovoltaic installed in or on a building shall have a dedicated meter to track PV production, in addition to the building sub-meter as outlined in the Standards.

1.04 SWITCHBOARDS/PANELBOARDS

- 1. Switchboards and panelboards shall be specified with copper bus bar only. Aluminum bussing is not allowed. Main switchboard and distribution boards shall be provided with power monitoring. This monitoring shall be connected to the BMS system for the building. This to be confirmed for each project.
- 2. The main electrical service switchboard for the building shall be rated 480Y/277V, 3-phase, 4-wire, 60Hz and shall be in the main electrical room on the ground floor. The main switchboard shall have fully rated main circuit breaker with ground fault interrupter for all service rated 1000A and above at 277/480V, 3-phase and shall have power monitoring capabilities.
- 3. All switchboards and distribution panelboards shall be provided with minimum 20% spare capacity for future use.

4. All lighting and power panelboards shall be sized with minimum 20% spare capacity for future use.
5. The distribution switchboards and panelboards shall have main circuit breakers and utilize copper bussing for phases, neutral and ground. All main circuit breakers in switchboards, distribution boards and panelboards shall be fully rated for fault current. Series rated equipment is not allowed.
6. Surge Protection Devices (SPS's) shall be installed on switchboards and panelboards serving IT equipment rooms for two-stage level protection. All emergency switchboards/panelboards shall have SPD's installed to comply with code.
7. All panelboards shall be in dedicated electrical spaces.

1.05 TRANSFORMERS

1. Dry type step-down transformers shall utilize copper coils with 115 degree Celsius rise insulation class. Aluminum wires for transformer coils are not allowed.
2. All dry type transformers shall be loaded up to 70% nameplate rating so that a 30% of connected load may be added in the future.
3. Outdoor transformers are not allowed.

1.06 EQUIPMENT WIRING TO MECHANICAL AND PLUMBING EQUIPMENT

1. Provide a fused disconnect switch at all powered HVAC and elevator equipment, including heat pumps and packaged units.
2. Provide control wiring and interlocking for single or simultaneous operation of motor loads per mechanical engineering requirements.

1.07 FEEDER CONDUCTORS

1. All secondary feeders shall consist of conduit and copper wire. Aluminum wire is not allowed.
2. Power conductors shall be copper single conductors rated 600 volts with Type THWN-2, rated 600V, 90 degrees C dry for damp locations. For equipment wiring, conductors shall be THNN (dry locations) or THWN-2 (wet locations).
3. Conductors must be marked with the manufacturer's name, date of manufacture, voltage, and classification letters and shall be inspected and approved before use. Insulated wire conductors, 600V or less, must be copper, with wire gauge, insulation type, temperature rating, and manufacturer clearly printed on insulation.
4. Mark each phase or leg in each panelboard with identifying tape. The insulation of all conductors is to be color coded throughout the length of the circuit.

5. Conductor color coding shall adhere to table below:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green
Purple	Switch leg	Pink

6. Wires shall not change colors between the breaker and the final termination. Aluminum conductors are not allowed.

1.08 WIRING DEVICES

- The receptacles shall be 20 Amp, 125v volt, 3 pole grounding type NEMA 5-20R with screw-type terminals. Ground-fault circuit interrupter outlets for wet area or sink counter locations shall be "feed-thru" type duplex receptacles with test reset buttons.
- Switches shall be minimum 20 Amp 277V, heavy duty toggle, single pole, with screw-type terminals. When multiple switches are installed, and voltage potential is 150V, approved isolation barriers shall be installed between switches.
- All device plates shall be labeled with originating panel and circuit numbers.

1.09 LIGHTING SYSTEMS

- Electrical lighting system shall be based on the latest version of the Illumination Engineering Society of North America (IESNA) guidelines for application and task-based lux targets. The lighting power density shall exceed California Title 24 as well as ASHRAE standards by at least 20% for energy efficiency and maximum power density.
- All lighting to be installed at any facilities shall use LED technology, except in case to case basis and only in cases where a new lighting technology is available that is more efficient than LED.
- LED luminaires shall conform to the following standards:
 - A minimum efficacy (lumens per watt) of 100
 - A coloring rendering index (CRI) of 90 or above.
 - Power factor of 0.9 or above
 - Total Harmonic Distortion (THD) of 20% or lower
 - A minimum of five years manufacturer's warranty
 - Luminaires that are dimmable
 - Color temperature (CCTC) of 3500Kelvin (exceptions may be granted on color temperature on a case to case basis in accordance with specific requirements for a given space with school representative's approval)

- D. Warranty period shall be minimum five years. The project team shall investigate the feasibility and practicality of purchasing longer warranty periods if manufacturer offers that option.
- E. Luminaires shall conform to Title 24 lighting and lighting control standards with the current edition of the applicable Code.
- F. All luminaires throughout the buildings shall be LED and shall be dimmable. Linear direct indirect pendants shall be provided in classrooms. Recessed volumetric shall be provide in labs. Recessed 2x2s shall be provided in corridors.
- G. All classroom lighting shall be dimmable with each row controlled independently and maximum foot candle level to be limited at 80%. Lights can be configured to automatic on to 50% or 70%. These levels may be adjusted based on the use of AV equipment usage within the classrooms.
- H. The preferred lighting solution for classroom lighting includes the specification of dimmable LED drivers.
- I. Exterior lighting in the parking lot shall be comprised of area luminaires. Pedestrian scale columns, bollards, illuminated benches, step lights, or other more decorative luminaires in the plaza. Direct, direct indirect, and decorative lighting shall be provided to illuminate the façade. All luminaires on the exterior shall meet the mandatory BUG rating requirements of Cal Green. All exterior light fixtures shall be installed to minimize glare and avoid spillage to adjacent properties.
- J. All emergency egress lighting and exit signs shall be served from standby emergency generator. Photometric studies shall be prepared for egress pathway on each floor with minimum design emergency lighting per CBC.
- K. Emergency lighting shall be provided in all IDF, MDF, and electrical rooms.
- L. All LED light fixtures for emergency lighting shall have LED drivers with emergency back-up using a centralized inverter system if an emergency generator is not provided.
- M. All emergency lighting shall override dimming mode and turn to full brightness during loss of normal power.

1.10 LIGHTING CONTROL SYSTEM

- A. The Building lighting control system shall comprise of a network relay control system.
- B. Classroom lighting fixtures and controls shall be specified from manufacturer as an integrated system.
 - 1. Classroom lighting shall be turned on manually and area control to be accessible to occupants to turn on the lighting. Lighting to operate automatically off when room becomes vacant.
 - 2. Light fixtures within 15'-0" of window shall be separately controlled (dimmed preferred or switched) with integrated daylight photo sensor to automatically reduce or eliminate energy waste.

3. A manual master on/off and raise/lower shall be provided to control the entire room with an option of a 4-scene control.
 4. The lighting control of classrooms shall be connected to a Central Lighting Control System
 5. Classroom shall have single gang wall mounted manual entrance control and single gang multi push button wall mounted teacher controller preset to achieve proper light levels for classroom functions (i.e., AV presentations). An option is to have a second control at teaching wall.
 - a. For other spaces a central lighting control system shall be provided.
 - b. Central lighting control system should provide on-off inputs from time clock.
 - c. Provide ceiling or wall mounted occupancy sensor with auto off as well as manual override for private room applications.
- C. The control system shall meet all Title 24 requirements including but not limited to dimming daylight harvesting in both primary and secondary daylight zones as well as vacancy, partial on, or partial off occupancy sensors. Dimming control shall be provided for all luminaires where dimming or multi-step is required. Demand response shall be provided as required for delivering a minimum of 15% reduction in lighting load in a uniform method.
- D. All exterior lighting shall be controlled by a photo-cell and the programmable network lighting control system. The control system shall meet all Title 24 requirements including part-night based control comprising of dimming and occupancy sensors. The control shall be available to combine set points between building occupation and site occupation. For example, the exterior lighting after dusk may be 100% when both building is open, and the exterior area is occupied, dropping back to 70% when the building is open, but the exterior area is unoccupied. Past building close and until dawn the setting may change such that the when the exterior area is occupied the lighting may be at 70% and reduce back to 50% when unoccupied.
- E. Sports lighting shall have independent lighting control and monitoring system that will control, monitor and manage the recreational lighting system.
- F. Theatrical lighting control system shall control the auditorium architectural house lighting, lobby lighting and selected work lighting through interface with low voltage relay panels.
- G. Theatrical lighting control system shall comprise of control panels, control electronics and data network, dimmers and circuit wiring devices.
- 1.11 POWER
- A. Classroom shall be provided with a separate branch circuit for general-purpose duplex receptacles, with a minimum of two (2) outlets in each wall maximum 15ft on center. Classroom shall be provided with separate outlets and circuit for other electrical equipment.
 - B. Computer classrooms shall have recessed floor-mounted outlet boxes with flush steel covers, in a 6ft by 6ft grid pattern for maximum workstation layout flexibility.
 - C. In corridors, receptacles shall be provided at maximum 50 feet intervals.
 - D. GFCI receptacles shall be provided on each exterior building wall and each restroom. Receptacles installed outdoors shall be in lockable boxes or cabinets.

- E. For East LA College and Southgate Environmental Center, provide three dedicated lockable electrical receptacles. Outdoor locations shall be coordinated with university.
- F. Receptacles in corridors, restrooms and on exterior walls shall be switched with a locked type switch installed in a Janitor's closet.
- G. Receptacles that automatically shut-off and controlled by occupancy sensors shall be provided in private offices, open offices, lobbies, copy rooms, and conference rooms.

1.12 SERVER ROOM ELECTRICAL EQUIPMENT

- A. A technical power system shall be provided consisting of an isolation transformer and dedicated 120/208V power panel with isolation ground bus, and transient voltage surge suppression (SPD) for server room equipment loads.
- B. Convenience outlets shall be provided at the server room perimeter, spaced 8 feet on center.
- C. Server room walls shall be outfitted with $\frac{3}{4}$ " thick fire-retardant treated plywood backboards from floor level to 8 feet above finished floor.
- D. Suspended or recessed LED with 50 LUX space illumination shall be provided.
- E. The server room wall shall be provided with a supplemental ground system with mounted copper bar for double lug connections.
- F. The server room permanent Uninterruptible Power Systems (UPS) integral to the electrical distribution system shall be provided.

1.13 ELECTRIC VEHICLE CHARGING STATIONS AND CLEAN AIR FUTURE CHARGING STATIONS

- A. Electric vehicle (EV) charging stations shall be commercial type and will include the following features:
 - 1. Software that will allow District staff to program hours of operation, rates, usage rules and the ability for staff to adjust each as needed, from a web-based interface and without having to contact a third party.
 - 2. Charger or software shall notify customers/users when their cars are charges and/or when charging time for which they pay has expired.
 - 3. Chargers shall accept payment from common credit cards and mobile devices such as smartphones. Chargers may also use third party pre-paid accounts through vendor's proprietary smart phone application or other vendor-approved payment system.
 - 4. Metering capability at each charger to allow operators to track times when chargers are in use, revenue produced by each charger, and other metrics.
- B. EV chargers shall be pole mounted or wall mounted with proper protection from traffic damage (bollards, curbs, etc.)

- C. EV chargers shall be level 2 which shall be installed on a dedicated 40 amp circuit. Provide dedicated Cat 6A cable from the charging stations to the nearest IDF room. Option: Level 3 chargers which require dedicated power source shall be considered if requested by the College and with adequate funding.
- D. EV chargers shall have minimum 25-foot length charging cord with automatic retract capability.
- E. Provide at least (1) charging station at the ADA compliant parking space.
- F. Equipment shall have a minimum 5-year warranty.
- G. For Clean Air Future Electrical Charging Stations (CAF ECS)
 - 1. Underground or overhead conduits between CAF ECS and electrical room shall have minimum two (2) inches diameter. Provide electrical circuit breaker per item #3 to satisfy the power need of all CAF ECS.
 - 2. All conduits must be terminated in weatherproofed concrete steel pull boxes near CAF ECS locations. Pull strings and identification tag must be installed in every empty conduit.
 - 3. The pull boxes shall be installed with easy access at following preferences locations.
 - 4. Landscape Area
 - 5. Hardscape Area
 - 6. Concrete Sidewalk
 - 7. Center Parking Space with 5 ft. clearance, if possible, to the nearest potential charging station.
 - 8. Parking Structure or building wall.
 - 9. Provide minimum of one (1) 2 inches diameter conduit from each CAF ECS to IT room for future communication need. Provide adequate data switch ports and/or router ports for meeting the data needs of all CAF ECS. Pull strings and identification tag shall be installed in all empty conduits.

1.14 SUSTAINABLE MEASURES

- A. Energy efficient lighting comprising of LED Lighting and LED exit signs.
- B. Occupancy sensor controls in offices, conference rooms, restrooms, etc. shall be configured to require manual activation of the lighting with the wall mounted switch. The vacancy sensor shall keep the luminaires energized while the space is occupied. The sensor shall turn the luminaires off after 15 minutes of vacancy but will reenergize the luminaires to their previous setting if occupancy is detected within 30 seconds of the "Off" event.

- C. The manual controls described above shall not override the daylight harvesting sensor(s) where present.
- D. Photo sensors or day lighting sensors where natural light is available.
- E. Use high efficiency motors and transformers.

1.02 INSTALLATION OF EQUIPMENT

- A. Install electrical equipment as specified in individual specification sections, and in accordance with the manufacturer's instructions, code requirements, and required access clearances.
- B. Rough-in locations for fixtures and equipment shall be determined from the unit itself or from the approved shop drawings.
- C. Arrange for necessary openings to allow for admittance of equipment. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, or other devices to allow later installation.
- D. Install equipment to permit easy access for normal maintenance.
 - 1. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.
 - 2. Notify the Owner's Representative in writing of relocation items which interfere with access.
 - 3. Suspended raceways and equipment shall be installed in accordance with the Applicable local, state, and national Building Codes.
 - 4. Provide all necessary anchoring devices and supports as required and stated elsewhere.
 - 5. Use structural supports suitable for equipment, or as indicated.
 - 6. Check loadings and dimensions of equipment with shop drawings.
 - 7. Do not cut or weld to building structural members.
 - 8. No material, device or equipment shall be shipped to site unless shop drawings have been approved for such, prior to shipment.

1.03 CONCRETE

- A. General: All concrete required shall be provided as specified in Division 03, Concrete.
- B. Housekeeping Pads and Isolation Bases:
 - 1. Provide all required dimensional drawings for bases and pads and location thereof.
 - 2. Provide all embedded anchor bolts and sleeving and ensure installation of same.

3. Provide seismic calculations.

C. Provide housekeeping concrete pads with minimum 3-inch (or larger per equipment anchorage requirement) wide edges and 3-inch high for indoor or 4-inch high for outdoor equipment, unless otherwise noted or required.

1.04 SEISMIC RESTRAINTS

A. Provide seismic restraints and supports for equipment and work as specified in the Specification Section 26 0548, this and other specification sections, and as shown on drawings.

1. Seismic restraints and supports shall be installed directly after installation of any work requiring them, to avoid concealment or difficulty of access.

2. Contractor shall be responsible for any costs and delays associated with gaining access to any installation needing restraints or supports.

1.05 PENETRATIONS

A. All penetrations through fire and smoke rated walls shall be sealed with fire-stopping material.

B. All penetrations through exterior walls and beneath slabs-on-grade shall be sealed with weatherproofing material.

C. All penetrations through acoustically treated walls shall be sealed with non-hardening resilient acoustic sealant.

D. All below grade conduit penetrations through the walls shall be individually sealed with Link-Seal or equal.

1.06 FIRESTOPPING

A. Provide sealing or stuffing material or assembly in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat and hot gases through fire rated construction.

B. Materials and Products:

1. Provide material listed in the UL Fire Resistance Directory for the UL system involved to achieve fire ratings of adjacent construction.

2. Materials shall have been tested to provide fire rating at least equal to that of the construction.

3. All firestopping products shall be from a single manufacturer.

C. Environmental Requirements:

1. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
2. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
3. Provide ventilation in areas to receive solvent cured materials and as required by manufacturer.

1.07 IDENTIFICATION

- A. The Contractor shall identify all conduit, cabling, devices, and equipment in accordance with Section 26 0553 – Identification for Electrical Systems.
- B. The Contractor shall submit a schedule for equipment identification.

1.08 SETTING OF PROTECTIVE DEVICES

- A. Prior to completion of the Project, set all protective device relays and internal settings to provide adjustment between upstream and downstream protective devices. Settings shall be based on the accepted coordination study.

PART 2 - FIRE ALARM SYSTEM

2.01 Design criteria CODES AND STANDARDS

- A. NEMA – National Electrical Manufacturers' Association
- B. UL – Underwriters' Laboratory
- C. California Building Code
- D. California Electrical Code
- E. California Fire Code
- F. CEC - California Electrical Code
- G. NEC - National Electrical Code
- H. NFPA - National Fire Protection Association
- I. IEEE – Institute of Electrical and Electronic Engineers
- J. ANSI – American National Standards Institute
- K. NETA – National Electrical Testing Association
- L. Americans with Disabilities Act

1.15 FIRE ALARM SYSTEM

- A. The fire alarm system shall be consistent with the DSA Fire and Life Safety and other applicable codes and shall be approved by DSA. The system shall be combination manual and automatic detection through complete area coverage as defined in NFPA 72. It shall also provide ADA compliant audible and/or visual alarm notification devices inside buildings and areas of assemblies within the site. The system shall be remotely monitored by UL listed central monitoring station. Each College Campus shall not have more than one fire alarm system if possible.
- B. The fire alarm system shall consist of but not limited to the following basic elements and components to be included in the design and installation:
1. Intelligent Fire Alarm Control Panel(s), network capable and expandable. Main Fire Alarm Control Panel shall be in the Main Electrical Room.
 2. No stand-alone systems. All systems and stations must register on the main fire alarm control panel.
 3. No Fire Alarm Control Panel shall be installed outdoor.
 4. Remote LCD display or FA annunciator in the Building Lobby.
 5. Remote power supplies and batteries for secondary power, 90-minute run-time.
 6. Manual pull stations selected areas.
 7. Addressable smoke and heat detectors necessary for complete area coverage, elevator recall / shut down and fan shut down.
 8. Addressable duct smoke detectors in HVAC supply and return ducts where required by code.
 9. Addressable beam smoke detectors in high ceiling areas such as gymnasiums and auditorium.
 10. Addressable devices to monitor fire sprinkler system tamper and flow switches including fire pump operational status and other fire protection/ suppression systems.
 11. Addressable control relays to initiate elevator recall / shutdown, fan shutdown, door holder power shutoff, unlock secured egress doors.
 12. Audible and visual alarm devices such as speakers and/or strobes to notify occupants of the school campus when under fire alarm condition.
 13. All fire alarm system components shall be CSFM and UL listed.
 14. Fire alarm system shall be installed with fiber network and to be installed in conduit.

15. The fire alarm system shall have emergency battery back-up if back-up generator is not available.
16. The fire alarm system must pass commissioning prior to acceptance.
17. All fire alarm devices shall be tested to NFPA 72E and results provided to the Facilities Director prior to acceptance of the system.
18. New buildings must be integrated into the existing main campus fire alarm system.
19. No manual pull stations in public hallways.
20. The fire alarm system shall be designed only for the space required. Oversizing the fire alarm control panel is not allowed.

END OF SECTION

SECTION 26 05 09
EQUIPMENT WIRING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment specified under other Sections or furnished by the Owner.

1.02 REFERENCES

- B. NEMA WD 1 - General Purpose Wiring Devices
- C. NEMA WD 6 - Wiring Device Configurations
- D. ANSI/NFPA 70 - National Electrical Code
- E. CEC – California Electrical Code

PART 2 PRODUCTS

2.01 CORDS AND CAPS

- A. Straight-blade Attachment Plug: NEMA WD 1.
- B. Locking-blade Attachment Plug: NEMA WD 5.
- C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: Oil-resistant thermoset insulated Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.
- E. Cord Size: Suitable for connected load of equipment and rating of branch circuit over-current protection.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.03 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

- B. Make cord connections to equipment using flexible conduit. Use liquidtight flexible conduit in damp or wet locations.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
- G. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

SECTION 26 05 13

MEDIUM VOLTAGE CABLE AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Medium Voltage Cables and Accessories.

1.02 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.
- B. Cable splice: Where the joining of two or more cable ends is accomplished by using field installed non-separable connector assembly that joins another cable end.
- C. Cable connector: Where a cable end is field joined to a factory-made separable connector assembly that can be attached and unattached to a mating termination fitting on a piece of equipment. 600A connectors are dead break rated and require the system to be shutdown prior to disconnection. 200A elbows shall be load-break rated.
- D. Cable termination: Where a cable end is field joined to a factory-made assembly with compression type lug bolted to a bus bar on the piece of equipment.
- E. Termination assembly(ies): Refers to all components associated with cable splices, cable connectors and cable terminations.
- F. Separable connector: A cable is terminated in a factory-made assembly unit that can be attached and unattached to another similar unit without damage to the connection or the cable ends.

1.03 SYSTEM DESCRIPTION

- A. Quality Standards: IEEE C2 and NFPA 70.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Cables:
 - 1. Type: MV105.
 - 2. Conductor: Copper.
 - 3. Conductor Stranding: Compact round, concentric lay.
 - 4. Strand Filling: Conductor interstices are filled with impermeable compound.
 - 5. Conductor Insulation: Crosslinked polyethylene.
 - a. Voltage Rating: 5kv or 15 kV as required.
 - b. Insulation Thickness: 133 percent.

6. Shielding: Copper tape.
7. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
8. Three-conductor cable assembly with ground conductors.
9. Cable Sheath: Interlocked aluminum.
10. Cable Jacket: Sunlight-resistant PVC.

B. Connectors:

1. Copper-Conductor Connectors: Copper barrel crimped.

C. Solid Terminations:

1. Multiconductor Cable Sheath Seals: Compound-filled, cast-metal body and heat-shrink sheath seal kit.
2. Shielded-Cable Terminations: Class 1, modular, heat shrink, Class 2, indoors, kit with stress-relief tube, or Class 3 with stress cone as required.

D. Separable insulated connectors with load-break cable terminators and test-point fault indicators.

E. Splice Kits: Premolded EPDM splicing body and separable multiway splice system.

F. Fault indicators.

2.02 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building wire
- B. Remote control and signal cable

1.02 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. NFPA 70 - National Electrical Code (NEC)
- C. CEC – California Electrical Code
- D. UL 44 – Thermoset-Insulated Wires and Cables
- E. UL 83 – Thermoplastic-Insulated Wires and Cables
- F. UL 854 – Service-Entrance Cables
- G. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords
- H. UL 2196 – Fire Resistive, Fire Resistant and Circuit Integrity Cables
- I. California Division of State Architect (DSA) Interpretation of Regulations

PART 2 PRODUCTS

2.01 BUILDING WIRE

- A. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits Larger Than 6 AWG in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
- C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600-volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.
- D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.
- E. Campus Standards
- F. LA Harbor College – Copper conductors only, THHN/THWN

1. LA Trade Tech College – Copper conductors only, THHN/THWN
- G. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
- H. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.
1. Color must be factory applied or field applied for sizes larger than 6.
 - a. Colors for 208Y/120 V Circuits:
 - b. Phase A: Black.
 - c. Phase B: Red.
 - d. Phase C: Blue.
 2. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Color for Neutral (Grounded Conductor): White or gray.
 - e. Color for Equipment Ground: Green.
 - f. Color for Isolated Ground: Green with two or more yellow stripes.

2.02 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.03 MINERAL-INSULATED CABLE, TYPE MI

- A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600v or less.
- B. Standards:
- C. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 1. UL 2196 for fire resistance.
 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper.

- E. Insulation: Compressed magnesium oxide
- F. Sheath: Copper

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system
- D. Grounding of systems over 1kV

PART 2 PRODUCTS

2.01 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 05 13 "Medium Voltage Cable and Accessories".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 26 05 53 for insulation color.
- D. Isolated Ground Conductors: Insulated. Refer to Section 26 05 53 for insulation color.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- H. Grounding Bus:
 - 1. Provide grounding buses in all electrical and telecommunication rooms,
 - 2. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" thick x 2" high x 24" length minimum or longer as required for all bonding connections.
- I. Intersystem Bonding Termination:

1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators, and pre-tapped holes.
2. Approved Manufacturers: Harger, Erico.

2.02 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.
- D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel Stainless steel.
- B. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to CEC/NFPA 70 using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet (6.0 m) of 1/2" (13mm) steel reinforcing bar.
- C. Building Steel
- D. Metal water piping at the water service entrance to the building

2.04 GROUNDING AT SERVICE:

- A. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
- B. Grounding Separately Derived Systems-Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.
- C. Grounding system to be tested to show compliance with 25 ohm requirement per the CEC and any lower ohm requirement required for specific project requirements to be lower.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hangers and Supports for Electrical Systems

PART 2 GENERAL

2.01 PRODUCTS

- A. Performance Requirements:
 - 1. Delegated Design: Engage a qualified structural professional engineer.
- B. Support, Anchorage, and Attachment Components:
 - 1. Galvanized-steel slotted support systems with metallic coatings.
 - 2. Aluminum slotted support systems with painted coatings.
 - 3. Nonmetallic slotted support systems.
 - 4. Raceways and cable supports.
 - 5. Steel conduits and cable hangers, clamps, and associated accessories.
 - 6. Support for nonarmored conductors and cables in vertical conduit risers.
 - 7. Structural steel for fabricated supports and restraints.
 - 8. Mounting, Anchoring, and Attachment Components:
 - a. Powder-actuated fasteners.
 - b. Mechanical-expansion anchors.
 - c. Concrete inserts.
 - d. Clamps for attachment to steel structural elements.
 - e. Steel springhead toggle bolts.
 - f. Threaded hanger rods.
- C. Fabricated Metal Equipment Support Assemblies:
 - 1. Welded or bolted steel shapes.

2.02 SELECTION

- A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by CEC. Minimum rod size must be 1/4 inch (6 mm) in diameter.

PART 3 EXECUTION

3.01 CONCRETE BASES

- A. 3000 psi, 28-day compressive-strength concrete.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rigid metallic conduit and fittings (RMC)
- B. Electrical metallic tubing and fittings (EMT)
- C. Flexible metallic conduit and fittings (FMC)
- D. Liquid tight flexible metallic conduit and fittings (LFMC)
- E. Rigid polyvinyl chloride conduit and fittings (PVC)
- F. Wall and ceiling outlet boxes
- G. Electrical connection
- H. Pull and junction boxes
- I. Rough-ins
- J. Handholes
- K. Accessories

PART 2 PRODUCTS

2.01 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

- A. Acceptable Manufacturers:
 - 1. Acceptable Manufacturers: Allied, LTV, Steelduct, Calbond Calpipe, Wheatland Tube Co, O-Z Gedney, or approved equal.
 - 2. Acceptable Manufacturers of RMC Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Crouse-Hinds, Killark, or approved equal.
- B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.
- C. Fittings and Conduit Bodies:
 - 1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
 - 2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.

3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete tight.
 4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp.
 5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
- D. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system. Acceptable Manufacturers: Calbond Calpipe, Robroy, T&B Ocal or approved equal.

2.02 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers of EMT Conduit: Allied, Calbond Calpipe, LTV, Steelduct, Wheatland Tube Co, or approved equal.
- C. Fittings and Conduit Bodies:
1. 2" Diameter or Smaller: Compression or steel set screw type of steel designed for their specific application.
 2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
 3. Larger than 2": Compression type of steel designed for their specific application.
 4. Acceptable Manufacturers of EMT Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, or approved equal.

2.03 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.
- B. Acceptable Manufacturers: American Flex, Alflex, Electri-Flex Co, or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
- D. Fittings and Conduit Bodies:
1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

3. Acceptable Manufacturers: O-Z/Gedney Co., Thomas & Betts, Appleton Electric, Electroline, Bridgeport, Midwest, Regal, or approved equal.

2.04 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

- A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alflex, Carlon (Lamson & Sessions), or approved equal.
- B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.
- C. Fittings and Conduit Bodies:
 1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
 3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Electroline, Bridgeport, Thomas & Betts, Midwest, Regal, Carlon (Lamson & Sessions), or approved equal.

2.05 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

- A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.
- C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.06 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2-inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast ferroalloy, or stainless steel deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

- E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.07 ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.08 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless-steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless-steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

2.09 ROUGH-IN

- A. Provide with one (1) flush mount double gang box with single gang plaster ring and appropriate cover plate with conduit stubbed to above the lay-in ceiling routed to the corridor cable tray.
- B. Technology Rough-in:
 - 1. Rough-in shall have one (1) 1" conduit.
- C. Technology Rough-in - Wall Phone:
 - 1. Mount on wall +54" or as noted in plans. Rough-in shall have one (1) 1" conduit.
- D. Technology Rough-in - Ceiling Flush Mounted:
 - 1. Mount flush in finished ceiling or as noted in plans. Rough-in shall have one (1) 1" conduit.

- E. Television Antenna Outlet Box Rough-in:
 - 1. Rough-in shall have one (1) 3/4" conduit.

2.10 HANDHOLES

- A. Handhole, composite polymer concrete body and cover. Stainless steel hardware. Bolted non-skid cover rated for 10,000 pounds. Design load occasional non-deliberate vehicular traffic. Stack units to achieve depth shown on plans. Units in landscaped areas shall be green in color. Dimensions as shown on plans.
 - 1. Approved Manufacturers:
 - a. Hubbell/Quazite
 - b. Carson Industries
 - c. Armorcast
 - d. Highline Products
 - e. Synertech
- B. Handhole, cast iron, hot dipped galvanized with checkered cover sidewalk weatherproof box, flat neoprene cover gasket. Stainless steel screw hardware. Mounted flush in concrete. 12"W, 18"L, 12"D or dimensions as shown on plans.
 - 1. Approved Manufacturers:
 - a. Appleton Electric
 - b. OZ Gedney
 - c. Crouse Hinds
- C. Handhole, concrete traffic box and galvanized steel checkered cover. Stainless steel hardware. Bolted cover and box rated for H/20 vehicular traffic. Reinforced concrete slab for bottom. 11"W, 18"L, 24"D or dimensions as shown on plans.
 - 1. Approved Manufacturer: Oldcastle Precast

2.11 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – Pad, Spec Seal, 3M or equal.
- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control – Seal Tight Backer Pad, L.H. DOTTIE Co., #68 or equal.

END OF SECTION

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Underground Ducts and Raceways.
- B. Handholes and Manholes

PART 2 PRODUCTS

2.01 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. General Characteristics: UL 6 and UL CCN DYIX.
- B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
 - 1. Interior Coating: Zinc.
 - 2. Minimum Trade Size: Trade size 3/4".
- C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
 - 1. Exterior Coating: PVC complying with NEMA RN 1.
 - 2. Interior Coating: Zinc.
 - 3. Minimum Trade Size: Trade size 3/4".

2.02 TYPE PVC RACEWAYS AND FITTINGS

- A. General Characteristics: UL 651 and UL CCN DZYR.
- B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
 - 1. Minimum Trade Size: Trade size 3/4".
 - 2. Markings: For use with maximum 90 deg C wire.
- C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
 - 1. Minimum Trade Size: Trade size 3/4".
 - 2. Markings: For use with maximum 90 deg C wire.
- D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:
 - 1. Minimum Trade Size: Trade size 2".
- E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Minimum Trade Size: Trade size 2".

2.03 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. General Characteristics: UL 514B and UL CCN DWTT.
2. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling.
 - c. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.04 DUCT ACCESSORIES

A. Duct spacers.

2.05 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Characteristics:

1. ASTM C858 for design and manufacturing processes.
2. SCTE 77.

B. Precast Concrete Handholes and Boxes:

1. Configuration: Units must be designed for flush burial and have closed bottom.
2. Frame and Cover:
 - a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - b. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - c. Cover Legend: Molded lettering, as indicated for each service.
3. Knockout panels.
4. Duct entrances in handhole walls.
5. Handholes 12 inch wide by 24 inch long and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover:

1. Configuration: Units must be designed for flush burial and have closed bottom unless otherwise indicated.
2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, as indicated for each service.
3. Direct-buried wiring entrance provisions.

4. Duct entrance provisions.
5. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.

2.06 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. General Characteristics:

1. ASTM C858 for design and manufacturing processes.
2. SCTE 77.

B. Precast Concrete Manholes:

1. Knockout panels.
2. Duct entrances in manhole walls.
3. Ground rod sleeve.
4. Source quality control.

C. Cast-in-place concrete manholes.

2.07 UTILITY STRUCTURE ACCESSORIES

A. Description: Utility equipment and accessory items used for utility structure access and utility support, listed, and labeled for intended use and application, and complying with the following local utility company requirements:

- B. Manhole frames, covers, and chimney components.
- C. Manhole sump frame and grate.
- D. Pulling eyes in concrete walls. Pulling eyes in nonconcrete walls.
- E. Pulling-in and lifting irons in concrete floors.
- F. Bolting inserts for concrete utility structure cable racks and other attachments.
- G. Ground rod sleeve.
- H. Expansion anchors for installation after concrete is cast.
- I. Steel cable rack assembly. Nonmetallic cable rack assembly.
- J. Fixed manhole ladders. Portable manhole ladders.
- K. Cover hooks.

2.08 DUCT SEALING

- A. Duct-sealing compound.
- B. Inflatable duct-sealing system.

2.09 EARTHWORK

- A. Restoration: Restore area immediately after backfilling is completed.
- B. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- D. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

END OF SECTION

SECTION 26 05 53

IDENTIFICATION OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Adhesive labels, markings, nameplates, and signs
- B. Wire and cable markers
- C. Raceway, box, and wire identification
- D. Equipment short circuit current rating (SCCR) labeling
- E. Electrical equipment labeling

PART 2 PRODUCTS

2.01 ADHESIVE MARKINGS AND FIELD LABELS

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).
 - 1. Label Size as follows:
 - a. Raceways: Kroy or Brother labels 1-inch (25mm) high by 12-inches (305mm) long (minimum).
 - 2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch (25mm) to 2 inches (50mm) in width.
- C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch (5mm) minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F (10°C to 176°C). Provide ties in specified colors when used for color coding.
- F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

- G. Aluminum, Wraparound Marker Bands: 1-inch (25mm) width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Brass or aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch (2mm) metal tags with stamped legend, punched for fastener.
- I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- J. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Font: Normal 721 Swiss Bold
 - b. Adhesive Labels: 3/16 inch (5mm) minimum text height
 - c. Vinyl / Plastic Laminate Labels: 3/4" inch (19mm) minimum text height

2.02 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.
- B. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Text Height: 3/8 inch (10mm) minimum
- C. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing; and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.03 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
 - 1. All Labels: Black letters on white face
 - 2. Normal Power and General Labels: Black letters on white face
 - 3. Medium Voltage (greater than 100 volts): Black letters on white
 - 4. Fire Alarm: Red letters on white face

5. Emergency: Red letters on white face
- B. Nameplates and Signs:
1. NORMAL POWER: Black letters on white face
 2. EMERGENCY: White letters on red face
 3. GROUNDING: White letters on green face.
 4. CAUTION or UPS: Black letters on yellow face
- C. Raceways and Conduit:
1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - a. Normal Power and General Distribution: Silver
 - b. Emergency Power Distribution System:
 - 1) All Emergency: Orange
 - 2) Legally Required Standby: Yellow
 - c. Fire Alarm System: Red
 - d. Temperature Controls: Blue
 - e. Ground: Green
 - f. Low Voltage and Telephone: Purple
- D. Equipment Labeling:
- a. Label all equipment as required by this section.
 - b. Provide Equipment short circuit current rating (SCCR) and Arc Flash labels on all equipment based on Electrical distribution Studies.

END OF SECTION

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SECTION 26 05 73

ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This specification sets forth requirements for both Design-Bid -Build and Design- Build projects of any size, which include any electrical scope of work. This specifications requires for the inclusion/implementation of an Arc Flash Hazard Analysis Study and the furnishing of Arc Flash Hazard Equipment Labels including the specification of the appropriate PPE level.
- B. This specification will outline the requirements for the A/E consultants, Contractors and Design-Builders for subject projects. This speciation is organized by delivery type for Design-Bid-Build (A/E Consultants and Contractors) and Design-Build (Design-Builders] project procurements
- C. All Studies to include:
 - 1. Short-circuit analysis and report.
 - 2. Selective coordination analysis and report.
 - 3. Arc-flash hazard analysis and report.

1.02 SCOPE

- A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.
- B. Contractor is required to provide a fully coordinated system for the normal and essential electrical system and all other locations indicated on the one-line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 PROJECT TYPES

2.01 DESIGN-BUILD-BID PROJECTS

- A. Designers — Consultants, as part of their professional services agreement, will be required to provide the work scope described per 3.01 of this specification. This work scope outlines the requirements for the Arc Flash Hazard Analysis Study (and other requirements as indicated) to be provided by the subject consultant and the associated Arc Flash Hazard Equipment Labeling requirements to be incorporated into the project plans and specifications.
- B. Contractors — Contractors as part of their construction contract will be required to furnish Arc Flash Hazard Equipment Labels as indicated/required per the project plans and specifications and per part 3.02 of this specification.

2.02 DESIGN - BUILD PROJECTS

- A. Design-Build — Design-Builders, as part of their Design-Build contract agreement, will be required to provide the work scope described per part 3.03 of this specification. This work scope outlines the requirements for the Arc Flash Hazard Analysis Study (and other requirements as indicated) and the associated Arc Flash Hazard Equipment Labeling to be provided.

PART 3 SCOPES

3.01 SCOPE OF SERVICES FOR ARC FLASH HAZARD ANALYSIS STUDY AND ARC FLASH HAZARD EQUIPMENT LABELS

- A. The following analysis/studies/reports are to be performed for all required electrical equipment as indicated below:
 - 1. The District shall be furnished a Short-Circuit Study in accordance with ANSI Standard C37 and IEEE Standard 141-1993.
 - a. The calculated short circuit currents levels shall be compared with the rated withstand ratings of equipment and interrupting ratings for overcurrent protective devices and a tabulation of all equipment devices shall state a status of either "pass" or "fail" based upon the above criteria.
 - b. A comprehensive report shall be prepared describing methodology and containing the results of the study in tabular form.
 - c. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
 - 2. The District shall be furnished a Protective Device Coordination Study in accordance with IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems — IEEE Standard 242-2001 (Buff Book).
 - a. A comprehensive report shall be prepared describing methodology and containing device settings in tabular form and time-current graphs of selected representative portions of each system including a simplified one-line diagram of the portion of the system included in the graph.
 - b. The report shall evaluate whether devices are selectively coordinated, and new settings shall be proposed where necessary to improve coordination.
 - c. Where necessary to improve arc flash hazard conditions, new settings shall be proposed. Where selective coordination shall be compromised by these proposed settings, the report shall so state.
 - d. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
 - 3. The District shall be furnished an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of NFPA 70E Standard for Electrical Safety in the Workplace. The Arc Flash Hazard Analysis shall be performed according to the IEEE Standard 1584 - 2002 and IEEE Standard 1584a - 2004 (Amendment 1).

- a. The study shall include all buses in the system where personnel may be exposed to the hazard, including :
 - 1) All system buses rated 240 V and higher and all system buses rated less than 240V where served by a transformer 12.5kVA and larger.
 - 2) Buses rated less than 240 V which are served by transformers rated less than 12.5kVA shall be labeled in accordance with NFPA 70E, Table 130.7(C)(9).
 - 3) System buses shall include, but not be limited to, switchgear, switchboards, transformer primary termination, transformer secondary termination, automatic transfer switches, manual transfer switches, motor starters, fused and non-fused disconnect switches, motor control centers, variable frequency drive input terminals, and sectionalizing switches.
 - 4) System buses shall include, but not be limited to, switchgear, switchboards, transformer primary termination, transformer secondary termination, automatic transfer switches, manual transfer switches, motor starters, fused and non-fused disconnect switches, motor control centers, variable frequency drive input terminals, and sectionalizing switches.
 - b. A comprehensive report shall be prepared describing methodology and containing worst- case arc flash information for each bus in tabular form.
 - c. The report shall identify locations where the calculated arc flash hazard presents a particular danger to members of the public, including students and others who may be exposed.
 - d. The report shall identify locations where physical changes to the system or added protective equipment can be applied to reduce the hazard.
 - e. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
4. The District shall be furnished a report on the observed condition of the electrical equipment and distribution systems based upon visual analysis and documentation and shall include :
 - a. The age of the equipment
 - b. The type of equipment
 - c. An engineering evaluation of the typical life expectancy for the type of equipment
 - d. Observed physical condition, including presence of corrosion, cleanliness, documentation of maintenance.
 - e. Presence of hazardous chemicals such as PCB oils.
 5. In the event new construction ties into as-built campus distribution or existing building distribution systems, determination of actual field conditions of the existing system shall be based upon the following methodology:
 - a. Review of available background information

- 1) Consultant shall review the available drawings for each system including existing one-line diagrams, cable schedules, plan and elevation drawings, equipment submittals and available short-circuit studies, protective device coordination studies and arc flash hazard analysis studies.
 - 2) Information from the above sources shall be used as a basis for modeling and as a starting point for site assessment and data gathering activities.
- b. Site assessment and data gathering
- 1) It is important that system impedances and protective device clearing times be modeled as accurately as possible to ensure that the results are representative of actual hazards, so Consultant is responsible for collecting actual system data.
 - 2) It is imperative that the data gathering be accomplished in a safe manner, and therefore it is desirable that equipment be de-energized while it is being examined if at all possible. This will require careful coordination with each campus Facility Director and electrical staff to schedule outages.
 - 3) All switching required to deenergize equipment and work required to open equipment for inspection by Consultant will be performed by a District approved electrician furnished by Consultant, or by a District electrician.
 - 4) If equipment must be examined hot, Consultant and electrician shall wear appropriate Personal Protective Equipment (PPE) based upon available information and the tables in NFPA 70E.
 - 5) Examine all electrical equipment and installations in the field to verify data on existing one-line diagrams and to collect data needed to model the facilities.
 - 6) The following types of data must be collected :
 - 7) Nameplate data from transformers, reactors, generators, circuit breakers and fuses.
 - 8) Relay and circuit breaker settings
 - 9) Fuse rating, type and speed
 - 10) Conductor sizes, types and approximate lengths
 - 11) Grounding configurations
 - 12) Utility source data including minimum and maximum fault values and X/R ratios
 - 13) System operating states
- c. System modeling and analysts
- 1) Systems for each building and for each campus medium-voltage distribution system shall be modeled in SKM Powertools for Windows™ most current version using system one-line diagrams, equipment manufacturer information, and data collected during site assessments.
 - 2) Key assumptions shall be stated in the report, and shall include the following:
 - 3) Working distance for buses with a nominal voltage of 1000 volts or greater shall be assumed to be 36 inches.

- 4) Working distance for buses with a nominal voltage of less than 1000 volts shall be assumed to be 18 inches.
 - 5) Clearing times for circuit breakers shall be based upon the equipment manufacturer's data under the assumption that these devices will operate according to specification. The report shall state that *poor* maintenance or age may adversely affect the performance and reliability of the protective devices.
 - 6) AJI faults shall be assumed to be three-phase faults. Single-phase equipment that meets the study criteria shall be analyzed as a three-phase equivalent.
 - 7) Maximum fault clearing time shall be capped at two seconds based upon IEEE 1584-2002 Annex B.1.2 and the assumption that an arc will self-extinguish, or personnel will move outside of the flash protection boundary within two seconds time. Should egress be from the fault hazard zone be unusually restricted, a longer maximum fault clearing time may be assumed provided an engineering case is presented for the longer clearing time with the report.
 - 8) Modes of operation
 - 9) Should alternate modes of operation exist, including operation of transfer switches and standby generators and alternate switching configurations within the medium-voltage distribution system each alternate configuration shall be studied and the worst-case results from among the modeled scenarios shall be reported and utilized for preparation of the arc flash labels.
6. Deliverables shall include the following :
- a. Bound printed copies and CDs or DVDs with electronic copies in Microsoft Word and PDF formats of each of the following reports:
 - 1) Short-Circuit Analysis
 - 2) Coordination Study
 - 3) Arc Flash Study
 - b. Full-sized one-line diagrams (electronic PDF and CAD file formats) and hard copy) for each building or other electrical system on a standard LACCD border in AutoCAD format per the District's CAD and BIM standards.
 - c. Incorporate Arc Flash Hazard Labels requirements/specifications into the project plans/specification to be furnished and installed by Contractor.
 - d. PDF files for Arc Flash Hazard labels suitable for use by Installing Contractor to prepare actual labels shall be provided for each bus as follows:
 - 1) Each label shall state the Arc Flash Hazard for the bus based upon the
 - e. worst case scenario for that bus.
 - 1) Labels shall comply with NFPA and OSHA requirements for Arc Flash Hazard labels.
 - 2) Label to be vinyl tape material with adhesive and be printed with indelible ink. The vinyl material should be 3 mil thick, and the material, adhesive, and ink should meet the latest version of ANSI Z535.4. The manufacturer should be DuraLabel or equal.

- 3) Labels shall identify the bus name, the equipment type, whether the bus is grounded or ungrounded, the working distance, the available 3-phase bolted fault current, the flash protection boundary, the incident energy at the working distance, the PPE level, the arc flash boundary, the limited approach boundary, the restricted approach boundary, the prohibited approach boundary, and the name and phone number of the Contractor.
- 4) Consultant shall include requirements for printing and installation of Arc Flash Hazard Labels by the Installing Contractor. Installing Contractor shall be required to print the labels from the Consultant provided PDF files and install the labels on the enclosure for each bus in a location where they are visible to the personnel before examining, adjusting, servicing, or maintaining the equipment.
- 5) CD with an electronic copy of the SKM PowerTools for Windows data files for all systems studies, including all scenarios, to be provided to District and Installing Contractor.

3.02 SCOPE OF SERVICES FOR ARC FLASH HAZARD EQUIPMENT LABELS

- A. Arc Flash Hazard labels shall be printed from District provided PDF files (via Design Consultant) and installed on each bus as follows:
 1. Each label shall state the Arc Flash Hazard for the bus based upon the worst case scenario for that bus.
 2. Labels shall comply with NFPA and OSHA requirements for Arc Flash Hazard labels
 3. Label to be vinyl tape material with adhesive, and be printed with indelible ink. The vinyl material should be 3 mil thick, and the material, adhesive, and ink should meet the latest version of ANSI Z535.4. The manufacturer should be DuraLabel or equal.
 4. Labels shall identify the bus name, the equipment type, whether the bus is grounded or ungrounded, the working distance, the available 3 -phase bolted fault current, the flash protection boundary, the incident energy at the working distance, the PPE level, the arc flash boundary, the limited approach boundary, the restricted approach boundary, the prohibited approach boundary, and the name and phone number of the Consultant.
 5. Contractor shall install the labels on the enclosure for each bus in a location where they are visible to the personnel before examining, adjusting, servicing, or maintaining the equipment.
- B. SCOPE OF SERVICES FOR ARC FLASH HAZARD ANALYSIS STUDY AND ARC FLASH HAZARD EQUIPMENT LABELS
 1. The following analysis/studies/reports are to be performed for all required electrical equipment as indicated below:
 - A. The District shall be furnished a Short-Circuit Study in accordance with ANSI Standard C37 and IEEE Standard 141-1993.

1. The calculated short circuit currents levels shall be compared with the rated withstand ratings of equipment and interrupting ratings for overcurrent protective devices and a tabulation of all equipment devices shall state a status of either "pass" or "fail" based upon the above criteria.
 2. A comprehensive report shall be prepared describing methodology and containing the results of the study in tabular form.
 3. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
- B. The District shall be furnished a Protective Device Coordination Study in accordance with IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - IEEE Standard 242-2001 (Buff Book).
1. A comprehensive report shall be prepared describing methodology and containing device settings in tabular form and time-current graphs of selected representative portions of each system including a simplified one-line diagram of the portion of the system included in the graph.
 2. The report shall evaluate whether devices are selectively coordinated, and new settings shall be proposed where necessary to improve coordination.
 3. Where necessary to improve arc flash hazard conditions, new settings shall be proposed. Where selective coordination shall be compromised by these proposed settings, the report shall so state.
 4. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
- C. The District shall be furnished an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of NFPA 70E Standard for Electrical Safety in the Workplace. The Arc Flash Hazard Analysis shall be performed according to the IEEE Standard 1584 — 2002 and IEEE Standard 1584a - 2004 (Amendment 1).
1. The study shall include all buses in the system where personnel may be exposed to the hazard, including:
 - a. All system buses rated 240 V and higher and all system buses rated less than 240V where served by a transformer 112.5kVA and larger.
 - b. System buses shall include, but not be limited to, switchgear, switchboards, transformer primary termination, transformer secondary termination, automatic transfer switches, manual transfer switches, motor starters, fused and non-fused disconnect switches, motor control centers, variable frequency drive input terminals, and sectionalizing switches.
 - c. Buses rated less than 240 V which are served by transformers rated less than
 - d. 112.5kVA shall be labeled in accordance with NFPA 70E, Table 130.7(C)(9).
 2. A comprehensive report shall be prepared describing methodology and containing worst- case arc flash information for each bus in tabular form.
 3. The report shall identify locations where the calculated arc flash hazard presents a particular danger to members of the public, including students and others who may be exposed
 4. The report shall identify locations where physical changes to the system or added protective equipment can be applied to reduce the hazard.

5. An engineering analysis of the results shall be provided along with recommendations for mitigation of any issues that are of concern.
- D. The District shall be furnished a report on the observed condition of the electrical equipment and distribution systems based upon visual analysis and documentation and shall include:
1. The age of the equipment
 2. The type of equipment
 3. An engineering evaluation of the typical life expectancy for the type of equipment
 4. Observed physical condition, including presence of corrosion, cleanliness, documentation of maintenance.
 5. Presence of hazardous chemicals such as PCB oils.
- E. In the event new construction ties into as-built campus distribution or existing building distribution systems, determination of actual field conditions of the existing system shall be based upon the following methodology:
1. Review of available background information
 - a. Consultant shall review the available drawings for each system including existing one-line diagrams, cable schedules, plan and elevation drawings, equipment submittals and available short-circuit studies, protective device coordination studies and arc flash hazard analysis studies.
 - b. Information from the above sources shall be used as a basis for modeling and as a starting point for site assessment and data gathering activities.
 2. Site assessment and data gathering
 - a. It is important that system impedances and protective device clearing times be modeled as accurately as possible to ensure that the results are representative of actual hazards, so Consultant is responsible for collecting actual system data.
 - b. It is imperative that the data gathering be accomplished in a safe manner, and therefore it is desirable that equipment be de-energized while it is being examined if at all possible. This will require careful coordination with each campus Facility Director and electrical staff to schedule outages.
 - c. All switching required to de-energize equipment and work required to open equipment for inspection by Consultant will be performed by a District approved electrician furnished by Consultant, or by a District electrician.
 - d. If equipment must be examined hot, Consultant and electrician shall wear appropriate Personal Protective Equipment (PPE) based upon available information and the tables in NFPA 70E.
 - e. Examine all electrical equipment and installations in the field to verify data on
 - f. existing one-line diagrams and to collect data needed to model the facilities.
 - g. The following types of data must be collected:
 - h. Nameplate data from transformers, reactors, generators, circuit breakers and fuses
 - 1) Relay and circuit breaker settings
 - 2) Fuse rating, type, and speed

- 3) Conductor sizes, types, and approximate lengths
- 4) Grounding configurations
- 5) Utility source data including minimum and maximum fault values and X/R
- 6) ratios
- 7) System operating states

3. System modeling and analysis

- a. Systems for each building and for each campus medium-voltage distribution system shall be modeled in SKM PowerTools for Windows most recent version using system one-line diagrams, equipment manufacturer information, and data collected during site assessments.
- b. Key assumptions shall be stated in the report, and shall include the following :
 - 1) Working distance for buses with a nominal voltage of 1000 volts or greater shall be assumed to be 36 inches.
 - 2) Working distance for buses with a nominal voltage of less than 1000 volts shall be assumed to be 18 inches.
 - 3) Clearing times for circuit breakers shall be based upon the equipment manufacturer's data under the assumption that these devices will operate according to specification. The report shall state that poor maintenance or age may adversely affect the performance and reliability of the protective devices.
 - 4) All faults shall be assumed to be three-phase faults. Single-phase equipment that meets the study criteria shall be analyzed as a three-phase equivalent.
 - 5) Maximum fault clearing time shall be capped at two seconds based upon IEEE 1584-2002 Annex B. 1.2 and the assumption that an arc will self-extinguish, or personnel will move outside of the flash protection boundary within two seconds time. Should egress be from the fault hazard zone be unusually restricted, a longer maximum fault clearing time may be assumed provided an engineering case is presented for the longer clearing time with the report.
- i. Modes of operation
4. Should alternate modes of operation exist, including operation of transfer switches and standby generators and alternate switching configurations within the medium-voltage distribution system each alternate configuration shall be studied and the worst-case results from among the modeled scenarios shall be reported and utilized for preparation of the arc flash labels.

F. Deliverables shall include the following :

1. Bound printed copies and CDs or DVDs with electronic copies in Microsoft Word and PDF formats of each of the following reports:
 - a. Short-Circuit Analysis
 - b. Coordination Study
 - c. Arc Flash Study

2. Full-sized one-line diagrams (electronic PDF and CAD file formats and hard copy) for each building or other electrical system on a standard LACCD border in AutoCAD format per the District's CAD and BIM standards.
3. Incorporate Arc Flash Hazard Labels requirements/specifications into the project plans/specification to be furnished and installed by Contractor.
4. PDF files for Arc Flash Hazard labels suitable for use by Installing Contractor to prepare actual labels shall be provided for each bus as follows:
 - a. Each label shall state the Arc Flash Hazard for the bus based upon the worst case scenario for that bus.
 - b. Labels shall comply with NFPA and OSHA requirements for Arc Flash Hazard labels.
 - c. Label to be vinyl tape material with adhesive and be printed with indelible ink. The vinyl material should be 3 mil thick, and the material, adhesive, and ink should meet the latest version of ANSI Z535.4. The manufacturer should be DuraLabel or equal.
 - d. Labels shall identify the bus name, the equipment type, whether the bus is grounded or ungrounded, the working distance, the available 3-phase bolted fault current, the flash protection boundary, the incident energy at the working distance, the PPE level, the arc flash boundary, the limited approach boundary, the restricted approach boundary, the prohibited approach boundary, and the name and phone number of the Contractor.
 - e. Consultant shall include requirements for printing and installation of Arc Flash Hazard Labels by the Installing Contractor. Installing Contractor shall be required to print the labels from the Consultant provided PDF files and install the labels on the enclosure for each bus in a location where they are visible to the personnel before examining, adjusting, servicing, or maintaining the equipment.
 - f. CD with an electronic copy of the SKM PowerTools for Windows™ data files for all systems studies, including all scenarios, to be provided to District and Installing Contractor.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 26.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by LACCD will manage the commissioning process.

1.02 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.03 SUMMARY

- A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems, and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.
- C. Provide all test results and commissioning reports as required by the related sections.

1.04 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

END OF SECTION

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SECTION 26 09 33

LIGHTING CONTROL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Line and low voltage standalone lighting controls
- B. Emergency transfer devices
- C. Distributed lighting control
- D. Central lighting controls
- E. Digital addressable lighting interface (DALI)
- F. Architectural dimmer rack and accessories
- G. DC dimming systems
- H. Time switches

PART 2 PRODUCTS

2.01 LIGHTING CONTROLS

- A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications.
- B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.
- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

2.02 LIGHTING CONTROL STATION

- A. The lighting control station shall contain the controls required by the lighting sequence of operation in a common cover plate. The controls may consist of switches, dimmers, occupancy sensors, pushbuttons, etc.
 - 1. In spaces where the wall control station is shown in multiple locations, the sequence of operation shall be the same at all locations, unless noted otherwise.
 - 2. The controls supplier shall prepare control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. The shop drawing submittal should be identified with the lighting sequence that the station provides. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

2.03 DEVICE COLOR

- A. All switch, lighting controls, and cover plate colors shall be the same as wiring devices, unless indicated otherwise.

2.04 COVERPLATES

- A. All switches and lighting controls shall be complete with cover plates that match material and color of the wiring device cover plates in the space.
- B. Where several devices are ganged together, the cover plate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.05 WALL SWITCHES

A. Single Pole Switch:

- 1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
- 2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.
- 3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
- 4. Approved Manufacturers: Hubbell DS120, Leviton 5621, Pass & Seymour 2621, Cooper 7601.
- 5. Campus Standards
 - a. LA Harbor College – Leviton, Hubbell
 - b. LA Trade Tech College – Leviton, Hubbell

B. Explosion Proof Single Pole Switch:

- 1. 120/277-volt, 20-amp maintained contact. Toggle handle. Suitable for use in Class 1, Division 1 areas.
- 2. Approved Manufacturers: Appleton EDSC175-F2, Crouse Hinds, Killark.

C. Key Lock Single Pole Switch:

- 1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
- 2. Extra heavy duty industrial locking series, specification grade
- 3. Approved Manufacturers: Hubbell HBL1221L, Leviton 1221-2L, Pass & Seymour PS20AC1-L, Cooper AH1221L.
- 4. Restroom Keyed Lighting switches – Campus Standards
 - a. LA Harbor College – Hubbell HBL extra heavy duty industrial locking series, back and side wired 15A, 120-277VAC or Leviton extra heavy duty specification grade key locking switches.

- b. LA Trade Tech College – Hubbell HBL extra heavy duty industrial locking series, back and side wired 15A, 120-277VAC or Leviton extra heavy duty specification grade key locking switches.
- D. Lighted Handle Single Pole Switch:
1. 120 volt maintained contact. Toggle handle. Light on when contact open (switch off). Side and back wired.
 2. Approved Manufacturers: Hubbell ExtHBL1221ILC, Leviton 1221-LHC, Pass & Seymour PS20AC1-CSL, Cooper 2221LTW.
- E. Weatherproof Single Pole Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired. Provide with weatherproof cover plate.
 2. Approved Manufacturers: Hubbell1221/HBL1795, Leviton 1221-2, Taymac MM180, Pass & Seymour PS20AC1/CA1-GL, Cooper 2221.
- F. Two Pole Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell HBL 1222, Leviton 1222-2, Pass & Seymour PS20AC2, Cooper 2222.
 3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
 4. Approved Manufacturers: Hubbell DS220, Leviton 5622, Pass & Seymour 2622.
- G. Three-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell 1223, Leviton 1223-2, Pass & Seymour PS20AC3, Cooper AH1223.
 3. 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
 4. Approved Manufacturers: Hubbell DS320, Leviton 5623, Pass & Seymour 2623, Cooper 7623.
- H. Key Lock Three Way Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
 2. Approved Manufacturers: Hubbell HBL1223L, Leviton 1223-2L, Pass & Seymour PS20AC3-L, Cooper AH1223L.
- I. Four-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
 2. Approved Manufacturers: Hubbell 1224, Leviton 1224-2, Pass & Seymour PS20AC4, Cooper AH1224.
- J. Three Position-Center Off Switch:
1. 120/277-volt, 20-amp, 2 pole maintained contact. Toggle handle, side and back wired.

2. Approved Manufacturers: Hubbell HBL1386, Leviton 1286, Pass & Seymour 1226, Cooper 2226.

K. Combination Single Pole Switch and GFCI Receptacle:

1. Single throw switch, 120-volt, 15-amp maintained contact. Toggle handle, side and back wired. NEMA 5-15R GFCI receptacle with test and reset buttons.
2. Approved Manufacturers: Hubbell GFSP15, Leviton 7229, Pass & Seymour 1595-SWTTR, Cooper VGFS15.

2.06 WALL DIMMERS

- A. UL listed with integral air-gap switch for on/off control.
- B. Integral EMI/RFI suppression.
- C. Non-viewable heat sink.
- D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.
- E. Dimmer to match device color.
- F. LED Electronic Driver Dimmer:
 1. 120-277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60629 Annex E.
 2. Approved Manufacturers: Compatible with provided LED driver.
- G. LED Electronic Driver Three-Way Dimmer:
 1. 120/277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60929 Annex E.
 2. Approved Manufacturers: Compatible with provided LED driver.
- H. Wall 0-10V Dimmer / Occupancy sensor:
 1. Wall switch with manual on/auto off. 120VAC load rating of 0-800 W for electronic ballast, LED. 277VAC load rating of 0-1,800 W for electronic ballast, LED. adjustable OFF delay. 0-10V dimming with up to 30ma sink. Automatic ON/OFF, manual ON/automatic OFF, or occupancy on to predetermined dimming level go to last dimming setting upon occupancy.
 2. Approved Manufacturers: Sensor Switch WSX D Series

2.07 LOCAL DAYLIGHTING CONTROLS

- A. Campus Standards
 1. East LA College and Southgate Environmental Center – Watt Stopper, Leviton, Lutron
 2. LA Mission College - Lutron
- B. Standalone Interior Photo Sensors:
 1. Daylight Level Sensor - On/Off Control - One Zone:

- a. On/Off control. Range of 10-200 FC. Adjustable dead band prevents cycling. Adjustable time delay. 120/277 volt.
 - b. Approved Manufacturers: Watt Stopper LS-102, Sensor Switch CM-PC, Hubbell Automation DLCPC Series, Greengate PPS-4.
2. Daylight Level Sensor and Controller - On/Off Control - Three Zones:
- a. On/off control of up to three 10-amp zones. Range of 10 to 200 FC. Adjustable dead band prevents cycling. Adjustable time delay. 120/277 volt.
 - b. Approved Manufacturers: Watt Stopper LCO-203/LS-290C, Hubbell Automation LUXSTATOCM/LUXSTATLS, LC&D Micro GR/2404 iDH/Pcell, Sensor Switch N-CMPC.
3. Daylight Level Sensor and Controller - 0-10V Dimming - One Zone:
- a. Dimming control of one 0-10V zone. Range of 10 to 200 FC. Adjustable dead band prevents cycling. Adjustable time delay. Coordinated with dimming ballast prior to submittal.
 - b. Approved Manufacturers: Watt Stopper LS-301, Hubble Automation DLC7, Sensor Switch N-CMADC.
4. Daylight Level Sensor and Controller - Dimming - Three Zones:
- a. Dimming control of up to three zones of 0-10V. Range of 10 to 200 FC. Adjustable dead band prevents cycling. Adjustable time delay. Coordinate with dimming ballasts prior to submittal.
 - b. Approved Manufacturers: Watt Stopper LCD-203/LS-290C, Hubbell Automation LUXSTATDCM/LUXSTATLS, LC&D Micro GR/2404 IDIM/Pcell, Sensor Switch N-CMADC.
5. Daylight Level Sensor and Controller - Multilevel/Bi-level On/Off Control - Dual Zones:
- a. Multilevel/bi-level on/off control of up to two 10-amp zones. Range of 10 to 200 FC. Adjustable dead band prevents cycling. Adjustable time delay. 120/277 volt.
 - b. Approved Manufacturers: Watt Stopper LCO-203/LS-290C, Hubbell Automation DLCPCC/DLCPCI, Sensor Switch CM-PC-DZ.
6. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.
7. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:
- a. Ambient sensitivity range between 1 and 1,000 foot-candles.
 - b. Time delay of 5 to 300 seconds.
 - c. Trigger setpoints with dead band adjustment.
8. Sensor shall provide on/off setpoints in quantity as specified on drawings and as shown in the sequence of operation.
9. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.
10. Output signal from sensor shall be linear with light level.
- C. Standalone Exterior Photo Sensors:

1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.
3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.
4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
 - a. Ambient sensitivity range of 5 to 1,500 foot-candles.
 - b. Adjustable setpoint.
 - c. Dead band adjustment by percentage of setpoint.
 - d. Time delay of up to five minutes.
5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
6. Approved Manufacturers: Paragon, Tork, Intermatic.

2.08 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Campus Standards

1. LA Southwest College – Watt Stopper, Lutron, match existing or equal.
2. LA Trade Tech College – Watt Stopper, Leviton

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
 - c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.

7. Power Supply and Slave Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
 8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
 9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
 10. Warranty: Five (5) year warranty.
- C. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. 360 Degree Coverage Pattern:
 - a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper DT 300 Series, Hubbell OMNI-DT2000 or ATD2000C, Greengate OAC-DT, Leviton OSC##-MOW, Sensor Switch CM PDT 10.
 2. Wall Mounted on Adjustable Swivel Mount:
 - a. Wall or ceiling sensor with adjustable settings to allow manual on/auto off or auto on/auto off. Integrated ambient light level sensor (2 to 100 FC range).
 - b. Approved Manufacturers: Watt Stopper DT-200 Series, Hubbell LODTRP, Leviton OSM12--M series, Sensor Switch WvPDT 16 Series.
 3. Wall Switch:
 - a. Wall switch with manual on/auto off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
 - b. Approved Manufacturers: Watt Stopper DW-100 Series, Hubbell LHMTS, Leviton OSSMT series, Sensor Switch WSD-PDT SA Series.
 4. Wall Switch:
 - a. Multi-relay wall switch with manual on/auto off for two separate loads. 120/277 VAC load relay rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
 - b. Approved Manufacturers: Watt Stopper DW-200 Series, Hubbell LHMTD, Leviton OSSMD series, Sensor Switch WSD-PDT 2P Series.
 5. Sensitivity Adjustment: Separate for each sensing technology.
 6. Detection Coverage:
 - a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
 - b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.
- D. Mask sensors where necessary to prevent nuisance switching from adjacent areas.

- E. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
1. High Bay - Aisle Coverage Pattern:
 - a. 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area. Initial settings: Time delay 10 minutes.
 - b. Approved Manufacturers: Watt Stopper HB-300 Series, Hubbell FHB 140 or HMHB series, Leviton OSFHU, Greengate OEF-P.
 2. High Bay - 360 Degree Coverage Pattern:
 - a. 20' to 40' mounting height. Minimum 1.3:1 walking motion coverage pattern to height ratio. Adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all luminaires in area.
 - b. Approved Manufacturers: Watt Stopper HB-300 Series, Hubbell FHB 140 or HMHB series, Leviton OSFHU, Greengate OEF-P.
 3. Wall Switch Occupancy Sensor:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC. Manual ON for vacancy sensing.
 - b. Approved Manufacturers: Watt Stopper PW-100 Series, Sensor Switch WSX, Hubbell LHIRS1 or AP1277, Leviton ODS15, Greengate OSW-P-0451.
 4. Dual Wall Switch Occupancy Sensor:
 - a. Passive infrared, zero crossing circuitry. Switches control two separate circuits or relays. Integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC. Manual ON for vacancy sensing.
 - b. Approved Manufacturers: Watt Stopper PW-200 Series, Sensor Switch WSD-2, Hubbell LHIRD2 or AP127712, Leviton ODS, Greengate OSW-P-0451.
 5. Ceiling Mounted - 360 Degree Coverage Pattern:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper CI Series, Sensor Switch CM-9, Hubbell Automation Omni-IR, Leviton OSC Series, Greengate OMR-P Series.
 6. Ceiling Mounted - 100 Degree Coverage Pattern:
 - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper WPIR Series, Sensor Switch CM-9, Hubbell LOIRWV or ATD1600W.
 7. Wall Mounted - 100 Degree Coverage Pattern:

- a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: Ambient sensor 40 FC.
 - b. Approved Manufacturers: Watt Stopper WPIR Series, Sensor Switch CM-9, Hubbell LOIRWV or ATD1600W.
8. With daylight filter and lens to afford coverage applicable to space to be controlled.
- F. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. 360 Degree 20' x 20' Hand Motion Coverage Pattern:
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-1100 series, Hubbell OMNI-US or ATU series, Leviton OSC series, Greengate ODC-U series.
 2. 35' x 30' Hand Motion Coverage Pattern:
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-2200 series, Hubbell OMNI-US or ATU series, Leviton OSC series, Greengate ODC-U series.
 3. 360 Degree Two-Sided Corridor Coverage Pattern:
 - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - b. Approved Manufacturers: Watt Stopper WT-2250 Series, Hubbell OMNI-US or ATU series, Greengate ODC-U Series.
 4. Wall Mounted:
 - a. Wall switch with adjustable settings to allow manual on/auto off or auto on/auto off.
 - b. Approved Manufacturers: Watt Stopper UW-100 Series, Hubbell AU12771,
 5. Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

2.09 EMERGENCY TRANSFER DEVICES

- A. Loss of power on normal circuit shall switch load to emergency power source.
- B. Provide suitable NEMA 1 enclosure and mounting per manufacturer specification.
- C. Emergency Lighting Control Override - Single Luminaire:
 1. Rated 2 amps at 120 volt incandescent and 10 amps at 277 volt fluorescent.
 2. Approved Manufacturers: Bodine GTD, Iota ETS, Watt Stopper ELCU-100.
- D. Emergency Lighting Control Override - Branch Loads:
 1. Rated 1000 watts at 120 volt incandescent and 20 amp at 277 volt fluorescent.

2. Approved Manufacturers: Bodine GTD20, Chloride Lightstar, Dual-Lite ATSD, Nine24 ELCR, Highlites HEPC.

E. Emergency Lighting Dimming Control Override:

1. Loss of power on normal circuit shall switch luminaires on at 100% rated light output.
2. Approved Manufacturers: Nine24 BLTCv3, nLight nPP16D (ER)

2.10 DISTRIBUTED LIGHTING CONTROL

A. Acceptable manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer can furnish the complete system as specified herein.

1. Acuity Controls nLight Series
2. Legrand Watt Stopper DLM Series
3. Hubbell Automation NX Series
4. Eaton Greengate RC3 Series (room-based system)
5. Osram Encelium Series
6. Lutron
7. Leviton

B. Campus Standards

1. West LA College – Acuity Controls nLight Series, Eaton Greengate, Osram Encelium Series, Watt Stopper, Leviton, Lutron
2. LA Harbor College – Lutron Eco system
3. LA Trade Tech College – LCD GR1400 series, nLight
4. LA Pierce College – Lutron, Leviton
5. LA Valley College – Watt Stopper, Lutron
6. East LA College – Smart System in IoT platform. The lighting controls shall communicate and work with HVAC controls through BACnet. Enlighted, Blue Ridge Technology.

C. System Description: The lighting control system shall be a network of remote modules connected to a digital network via network hubs and controlled through a system server / central station. Lighting control devices connect to the modules and communicate via the digital network with the system server. System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors, network interfaces, and hubs. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

D. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

- E. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.
- F. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.
- G. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system.
- H. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation, and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- I. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs, and control system server/ central station such that system performs as described. Server shall be provided with monitor, keyboard, and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.
- J. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network hub shall be fed from an equipment emergency circuit at a minimum.

2.11 CENTRAL LIGHTING CONTROL - RELAY PANEL TYPE (NETWORK)

- A. Acceptable manufacturers listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.
- B. Lighting Control. Refer to schedules for size, rating, and configuration.
 - 1. The lighting control system shall be a network of lighting relay panels connected to a digital network and controlled through a system server / central station. Lighting control devices connect to the relay panels and communicate via the panel controller with the system server. System includes all associated network interfaces and wiring, relay panels, control modules, input modules, panel processors, relays, photocells, switches, dimmers, time clock, and occupancy sensors.
 - 2. System shall include server / central station with operating software, data network, and BACnet IP communication, with other systems as described. System communication protocol shall be compatible with the building automation system (BAS).
 - 3. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

- C. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between system devices, network, and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, 2 4 8 GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard, and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.
- D. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.
1. Typewritten Directory: Identifies each relay as to load controlled.
- E. System Power Supply: Transformer and full-wave rectifier with filtered DC output for panel, controllers, and control devices. Feed from an equipment emergency circuit at a minimum.
- F. Relays: Mechanically latched unless otherwise indicated; split-coil, momentary-pulsed type, rated 20°A, for tungsten filaments and NEMA for electronic ballast rated. Rated for 50,000 ON/OFF cycles at rated capacity.
- G. Controllable Breaker (Option):
1. Solenoid operated thermal magnetic breakers to provide control, overload protection, and short circuit protection.
 2. Ratings of 120/240V AC; 15, 20 and 30-amp; 1- and 2-pole, 277/480V AC, 15, 20 and 30-amp; 1 and 2-Pole. Minimum AIC rating to be 14,000 at 480Y/277 and 65,000 at 120/240.
- H. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.
- I. Central Lighting Control Features and Functions:
1. Dimming system presets shall be programmable via preset/fader station directly at the control panel, or via network-based workstation software. Dimming presets shall have discrete fade times with 0.1 second resolution, programmable from zero to 24 hours, and shall be selectable via button, fader, clock event, macro or network interface.
 2. Clock events shall be activated by calendar schedule, by day type and/or specific day programming, including every day, weekday, weekend, S, M, T, W, H, F, S, Holiday. Clock events shall also be activated by astronomical events, which will compensate for daylight savings time and will have programmable setback periods relative to sunrise and sunset.
 3. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web-based software or other devices connected to programmable inputs in a lighting control panel.
 4. Channels for grouping relays shall be provided, each with an associated pushbutton to toggle the channel ON/OFF and a terminal block for a separate dry contact input. Any number of relays in the panel can be assigned to each channel, with overlapping allowed. Channels shall be set up via communication line communications and networking. Each channel pushbutton shall provide LED status indication. The panel shall also have the ability to assign functions to relays independently of the channels. Panels shall be addressable with DIP switches or other local means to set panel address.
 5. System shall accept any type of switch input, including momentary or maintained.

6. System shall support by relay or zone the "blink warning" function. System shall be capable of flashing lights Off/On prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and shall not exceed two (2) hours.
 7. System shall provide temporary override conditions for each relay or dimmer so that lights can always be turned on.
 8. All programming and scheduling shall be able to be done locally at the master lighting control panel and remotely via the Internet. Remote connection to the lighting control system shall provide real-time control and real-time feedback. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go offline, all system programming uploaded to the lighting control system shall continue to operate as intended.
 9. All programs, schedules, time of day, etc., shall be held in non-volatile memory for a minimum of two (2) years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.
 10. Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection.
- J. BACnet or Facility Management Control System (FMCS) Protocol Interface: Provide BACnet-over-IP interface to building controls system or a Direct Digital Controls native protocol interface to read, control and monitor status of all lighting zones and groups in real time.
- K. Telephone Override Interface: A voice-prompted telephone override interface module shall accept up to three (3) phone lines and allow up to three (3) simultaneous phone calls. Voice-prompted menu and up to 999 unique passcodes shall be standard with each interface module. Override time shall be a maximum of 120 minutes.
- L. Ethernet Connection Port - Interoperability:
1. System shall include an Ethernet port for connection to Owner's TCP/IP network, permitting remote management of system from local or wide area network connection.
 2. Contractor shall coordinate with technology vendor to provide an Ethernet connection to (LCP) panel as specified by manufacturer.
- M. RS232 Interface for Audio/Visual Interface - Control Interface Stations:
1. Control interface stations shall provide an interface for PC and/or A/V connection to lighting control system.
 2. Stations shall utilize RS-232 standard protocol and shall be appropriate DIN-style connector.
- 2.12 CENTRAL LIGHTING CONTROL INTERFACES
- A. Manual Switches, Stations and Plates:
1. Switches: Modular, momentary pushbutton, with addressable capabilities to control the luminaires assigned to that switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.

2. Preset/fader stations shall operate using programmable buttons and/or faders as indicated on drawings.
 3. Integral Pilot Light or LED: Indicate that controls are active or powered by being on continuously when powered or when pushbuttons are actuated.
 4. Labeling of buttons and faders shall be engraved/screened by manufacturer, using approved text returned with shop drawing submittals.
 5. Station control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via direct or network connection. Function options include: preset selection, manual mode, record mode, station lockout, raise/lower, macro, cue, and room join/separate.
- B. LCD Station:
1. Backlit liquid crystal display (LCD) shall operate using buttons, faders, and other images on separate programmable control pages via touchscreen interface.
 2. LCD station contrast and brightness shall be adjustable. It shall be possible to program the station to dim during periods of inactivity.
 3. LCD stations shall support import of bitmap image files to customizable pages.
 4. Permanently installed stations shall be either fully or semi-recessed in manufacturer-furnished backbox and trim assembly, with no visible fasteners or hardware.
 5. Portable stations shall nest into permanent wall docking station furnished by manufacturer and shall not require user to connect any umbilicals or plugs when inserting or removing the portable device. Docking station shall provide charging and communication with portable device when docked.
- C. Wireless Controls (Infrared):
1. Portable wireless IR transmitter for remote control of lighting control panel. Transmitter shall have at least four (4) eight (8) scene control with engraved names below each button.
 2. Infrared receiver shall be recess mounted with an integral LED to indicate when signal has been received. Receiver shall operate reliably within a 40-foot distance.
- D. Portable Control Console and Connector Station:
1. Portable control console with minimum 10-foot cable and interface plug.
 2. Connector station receptacle, flush mounted, to allow portable console to communicate with lighting control system. Mounts in industry standard backbox.
- F. Network Daylight Level Sensor:
1. Networked sensors shall serve as a measurement device that provides ongoing read-back of sensor settings to lighting control network or daylight controller. Refer to the sequence of operation for actions to be triggered at various read-back values.
 2. Sensor shall be ceiling- or wall-mounted for range and viewing angle, meeting application requirements as outlined in the sequence of operation. Outdoor sensors shall be wet location listed and designed specifically for outdoor use.
 3. Output signal from sensor shall be linear with light level. Network connection permits remote query of sensor status and value via control software. All adjustments, with the exception of sensor range, shall be made via network connection.
 4. Sensor shall have adjustable sensitivity range to permit use as scheduled.

2.13 LIGHTING CONTROL SYSTEM – DIGITAL ADDRESSABLE LIGHTING INTERFACE (DALI)

- A. Acceptable manufacturers listed below meet the qualifications as outlined within this specification. Contractor is responsible for verifying that selected manufacturer can furnish the complete system as specified herein.
1. Starfield Controls, Inc.
 2. Tridonic Inc.
- B. System Description: The lighting control system shall consist of digital lighting control network connecting DALI-compliant digital addressable ballasts, control modules, and lighting control devices directly with a system server / central control station. Individually addressable electronic ballasts, control modules, and control devices are operated from signals received through DALI-compliant bus from a variety of DALI-compliant digital controllers and interfaces and programmed through the system server / central control station. System includes all associated network bus and wiring, DALI controllers and interfaces, panels, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize DALI-compliant ballast and dimming modules provided with light fixtures.
- C. Control Devices: All occupancy sensors (ultrasonic, IR, and dual technology type), photocells, switches, and timers shall be provided with system and be DALI compliant. Devices shall be designed to operate on system network. Supplemental DALI-compliant signal repeaters and controllers shall be provided as required. This equipment shall be identified in shop drawing submission.
- D. System shall include server / central station with DALI operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system.
- E. System server / central station shall provide programmable operation of lights connected via system bus and controlled with system devices. System software shall provide control of DALI ballast, control modules and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- F. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs, and control system server/ central station such that system performs as described.

2.14 ARCHITECTURAL DIMMER RACK AND ACCESSORIES

- A. Dimmer Rack and Control Processor:
1. 12 24 48 dimmer capacity. 120/208 volt, 3-phase, 4-wire, _____-amp main breaker. Refer to Dimmer Rack Schedule on drawings for further information.
 2. Approved Manufacturers: Unison DR Series, Strand DE Series, Lutron Grafik Eye 4000/5000/6000.
- B. Dimmer Control Station
1. _____ buttons, presets, and on/off control.
- C. Dimmer Control Station with Faders
1. _____ buttons, _____ faders.

D. Dimming / Relay Performance Requirements:

1. The component's maximum current rating shall be at least two times the dimmer's/relay's rated operating current.
2. Capable of withstanding repetitive in-rush current of 50 times operating current without impacting lifetime of dimmer/relay. Design and test dimmers/relays to withstand line-side surges without impairment to performance.
3. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

E. Dimmers:

1. Each dimmer to incorporate electronic "soft start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
2. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
3. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.
4. Possess ability to have load types assigned per circuit, configured in field.
5. Minimum and maximum light levels user adjustable on output-by-output basis.
6. Line Voltage Dimmers: Meet following load-specific requirements:
 - a. Magnetic Low Voltage (MLV) Transformer:
 - 1) Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
 - 2) Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
 - b. Electronic Low Voltage (ELV) Transformer:
 - 1) Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
 - c. Fluorescent Electronic Dimming Ballast: Refer to Section 26 51 00 for dimming ballast specifications and performance.
7. Low Voltage Dimming Modules: Meet the following requirements:
 - a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
 - b. Single low voltage dimming module; capable of controlling following light sources:
 - 1) 0-10V analog voltage signal
 - 2) DSI digital communication
 - 3) DALI broadcast communication IEC 60929
 - 4) PWM IEC 60929

F. Non-dim circuits to meet the following requirements:

1. Rated life of relay at full load: Minimum 1,000,000 cycles.

2. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
3. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

2.15 TIME SWITCH

- A. Time switch, 7-day, electronic, 30 setpoints available, LCD display, 12 or 24-hour format, minimum 200 hours battery backup, one SPDT 15-amp contact, UL listed.
 1. Approved Manufacturers: Paragon EC71/30S, Tork EW101S, Intermatic ET70115C.
- B. Time switch, 7-day, 2 channel, electronic, two SPDT 15-amp contacts, two separate programs with 16 setpoints available, LCD display, 12 or 24-hour format, minimum 100 hours carry-over, UL listed.
 1. Approved Manufacturers: Paragon EC72, Tork DTS 200A, Intermatic ET70215C.
- C. Astronomical time switch, 7-day, 1 channel, electronic, one SPDT 5-amp contact, LCD display, 12 or 24-hour format, minimum 100 hours carryover, UL listed.
 1. Approved Manufacturers: Paragon EC71ST, Tork DWZ100A, Intermatic ET70115C.
- D. Timer, 24-hour, 20-amp continuous contacts, 1 N.O. and 1 N.C. contacts, spring wound backup, 120 volt, override switch, UL listed.
 1. Approved Manufacturers: Paragon 4213-OS, Tork 7200L, Intermatic T173CR.

2.16 CONDUCTORS AND CABLES

- A. Control Wiring:
 1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 26 05 13 "Medium Voltage Cable and Accessories."
 2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.
 3. Tap conductors to dimming ballasts: Solid copper conductors of 18 AWG with insulation voltage rating equal to that of the line-voltage wiring and insulation temperature rating not less than 90°C.
 4. Network cabling as required by manufacturer.
- B. Splices and Taps:
 1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

END OF SECTION

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SECTION 26 10 00

MEDIUM VOLTAGE ELECTRICAL DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Medium Voltage Metal-Enclosed Switchgear.

1.02 SYSTEM DESCRIPTION

- A. Indoor and outdoor metal-enclosed interrupter switchgear with solidly grounded neutral system.
- B. Quality Standard: IEEE C37.20.3.

PART 2 PRODUCTS

2.01 SWITCHGEAR ENCLOSURE

- A. Indoor Enclosure: Steel.
- B. Outdoor Enclosure: Weatherproof, galvanized steel; aisleless; with asphaltic undercoating.
 - 1. Features:
 - a. Wind resistant up to 125 mph wind.
 - b. Space heater.
 - c. Louvers with insect screens and filters.
 - d. Weatherproof ground-fault interrupter duplex receptacle.
 - e. Power supply for heater and receptacles.
 - f. Skid mounted.
- C. Finish: Manufacturer's standard color with high-corrosion resistance coating.

2.02 FUSIBLE LOAD INTERRUPTER SWITCHGEAR

- A. Dead front, metal-enclosed, and fixed-mount.
 - 1. Front and rear access.
 - 2. Viewing window to show view of the position of the interrupter.
 - 3. Mechanical door interlock preventing opening when the switch is open.
 - 4. Padlocking and tagging switch in opened or closed position.
 - 5. Switch position indicator.
 - 6. Hinged front and rear vertical section cover.
 - 7. Bus: Tin-plated copper.

8. Auxiliary vertical sections and compartments for utility or owner metering.
9. Surge arresters.
10. Manual load-interrupter-type switches.
11. Accessories:
 - a. Interrupter switchgear test, inspection, maintenance, and operation tools.
 - b. Fuse-handling tool.

2.03 INSTRUMENTS

- A. Instrument Transformers: Comply with IEEE C57.13.
 1. Potential transformers.
 2. Current transformers.
- B. Multifunction digital meter and monitor.

2.04 PROTECTIVE RELAYS

- A. Multifunctional, solid-state microprocessor-based relay systems.
- B. Overcurrent and Ground-Fault Protective Relays:
 1. Device Functions: 51/50 and 51/50N.
 2. Field-selectable relay settings.
 3. Programmable primary current-transformer ratings from 5 to 5000 A.
 4. Field-selectable phase and ground protection.
 5. Field selectable phase instantaneous overcurrent trip pickup point.
 6. Contacts:
 - a. Two Form-A contacts.
 - b. Field selectable into contact pairs.
 7. Alphameric Display:
 8. Relay alarm and trip contacts.

2.05 CONTROL POWER SUPPLY

- A. Control transformer to supply 120 V(ac).
- B. Uninterruptible ac power supply.

2.06 CONTROL NETWORK

- A. Controllers for support of serial MS/TP and Ethernet IP communications and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

2.07 WARNING LABELS AND SIGNS

- A. Engraved, laminated acrylic or melamine equipment identification labels.

END OF SECTION

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SECTION 26 12 16

DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dry-type, Medium-Voltage Transformers

1.02 SYSTEM DESCRIPTION

- A. Comply with IEEE C2.
- B. Comply with IEEE C57.12.01.

PART 2 PRODUCTS

2.01 GENERAL

- A. Campus Standards
 - 1. LA Harbor College – Standard general dry-type Square D
 - 2. LA Trade Tech College – Standard general dry-type Square D

2.02 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper. See Editing Instruction No. 1 in the Evaluations for guidance on retaining "Surge Arresters" Paragraph below.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.
- C. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.
 - 1. Self-Cooled Rating, Class
- D. Coils Insulation Systems:
 - 1. Primary and secondary coil assemblies must be manufactured using polyester VPI system.
 - 2. Primary and secondary coil assemblies must be manufactured using silicone resin VPE system.
- E. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
- F. Efficiency: Comply with 10 CFR 431, Subpart K.

- G. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
- H. Tap Changer: External, for de-energized operation.
 - 1. Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.
- I. Enclosure:
 - 1. Provide with provisions for lifting and anchoring frame to concrete pad.
 - 2. With integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
 - 3. Enclosure Finish:
 - a. Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistant complying with IEEE C57.12.28.
 - b. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
 - c. Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands 120 hours of exposure to salt-spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of 1/16 inch from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654 with rating of not less than 7 in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.
- J. Sound level must comply with requirements of NEMA TR 1.
- K. Capacities and Characteristics:
 - 1. Enclosure: Ventilated power transformer, NEMA 250 Type 1 enclosure.
 - 2. Additional IEEE Standards: Comply with IEEE C57.12.50.
 - 3. Comply with UL 1562 listing requirements.
 - 4. Connections:
 - a. Primary: Air-filled terminal cabinet for cable connection.
 - b. Secondary: Air-filled terminal cabinet for cable connection.
 - 5. Transformer Ratings.
 - a. Impedance: Not less than 5.75 percent.
 - b. Temperature Rise: 150 deg C.
 - c. Coils Connection:
 - 1) Line-Side Winding: Delta.
 - 2) Load-Side Winding: Wye.
 - d. Voltage and BIL Ratings:
 - 1) Nominal primary phase-to-phase voltage and BIL: 4160 V, 30 kV.

- 2) Nominal secondary voltage and BIL: 480Y/277 V, 10 kV.
- e. K-Factor: , complying with UL 1562.
6. Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
7. Transformer Accessories:
 - a. Dial-type analog thermometer with alarm contacts.
 - b. At least four stainless steel ground connection pads.
 - c. Provisions for jacking, lifting, and towing.
 - d. Machine-engraved nameplate made of anodized aluminum or stainless steel.
8. Heaters: Where outdoor cast-coil transformers are shown on Drawings, they must include thermostatically controlled space heaters powered from external source that remains energized when transformer is de-energized.

END OF SECTION

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SECTION 26 12 19

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers

1.02 SYSTEM DESCRIPTION

- A. Comply with IEEE C2.
- B. Comply with IEEE C57.12.00.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Windings Material: Copper.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution Class.
- C. Efficiency: Comply with 10 CFR 431, Subpart K.
- D. Insulation: Average temperature rise 65 deg C and hottest spot 80 deg C.
- E. Tap Changer: External handle, for de-energized operation.
- F. Tank: Sealed, with welded-on cover. Designed to withstand internal pressure of not less than 7 psi without permanent distortion and 15 psig without rupture. Comply with IEEE C57.12.36.
- G. Mounting: Integral skid mounting frame.
- H. Insulating Liquids:
 - 1. Edible-seed-oil-based dielectric.
 - 2. Biodegradable and nontoxic dielectric.
- I. Sound level must comply with NEMA TR 1 requirements.
- J. Corrosion Protection:
 - 1. Transformer coating system must be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2. Fabricate front sill, hood, and tank base of single-compartment transformers from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage, complying with requirements of IEEE C57.12.28, standard color green.
3. Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.02 THREE-PHASE TRANSFORMERS

A. Compartment Construction:

1. Single-compartment construction.
2. Double-compartment construction.

B. Line-Side Section: Dead-front design.

1. Bushing inserts and feed-through inserts:
 - a. Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.
 - b. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.
2. Bushing wells configured for loop-feed application.
3. Access to liquid-immersed fuses.
4. Dead-front surge arresters.
5. Tap-changer operator.
6. Load-Break Switch:
 - a. Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with continuous current rating and load-break rating of 200 A and make-and-latch rating of 12 kA(rms sym.).
 - b. Loop-feed sectionalizing switches, using three two-position, liquid-immersed-type switches for closed transition loop-feed and sectionalizing operation. Voltage class and BIL must match that of separable connectors, with continuous current rating and load-break rating of 300 A Insert amperage and make-and-latch rating of 12 kA(rms sym.). Switch operation must be as follows:
 - 1) Position I: Line A connected to line B and both lines connected to transformer.
 - 2) Position II: Transformer connected to line A only.
 - 3) Position III: Transformer connected to line B only.
 - 4) Position IV: Transformer disconnected, and line A not connected to line B.
 - 5) Position V: Transformer disconnected, and line A connected to line B.

C. Load-Side Section:

1. Metering: Coordinated with and complying with requirements of Section "Electricity Metering." the following:
 - a. Sensors.
 - b. BAS interface.
 - c. Kilowatt-hour meter.
 - d. Kilowatt-hour demand meter.

- D. Capacities and Characteristics:
 1. Power Rating: As load requires, maximum size 2000 KVA.
 2. Voltage Ratings: 12,470 V - 480Y/277 V.
 3. Taps: Comply with IEEE C57.12.26 requirements.
 4. Transformer BIL (kV): Comply with IEEE C57.12.26 requirements.
 5. Minimum Tested Impedance (Percent) at 85 deg C: 2.87.
 6. K-factor: K-1 complying with UL 1562.
 7. Comply with FM Global Class No. 3990.
 8. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

- E. Transformer Accessories:
 1. Drain and filter connection.
 2. Filling and top filter press connections.
 3. Pressure-vacuum gauge.
 4. Dial-type analog thermometer with alarm contacts.
 5. Magnetic liquid level indicator with high and low alarm contacts.
 6. Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer. With alarm contacts and manual bleeder.
 7. Stainless steel ground connection pads.
 8. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
 9. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide with seal-in delay.

END OF SECTION

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SECTION 26 22 00

LOW VOLTAGE TRANSFORMERS (DRY-TYPE TRANSFORMERS (600 V AND LESS))

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dry type two winding transformers
- B. Dry type harmonic mitigating transformers

PART 2 PRODUCTS

2.01 DRY TYPE TWO WINDING TRANSFORMERS

- A. Approved Manufacturers:
 - 1. MGM
 - 2. Hammond
 - 3. General Electric
 - 4. Square D
 - 5. Eaton
- B. Campus Standards
 - 1. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler Hammer
 - 2. LA Harbor College – Eaton Cutler Hammer, GE, Square D
 - 3. LA Mission College – Square D
 - 4. LA Pierce College – Eaton Cutler Hammer, Square D, GE
 - 5. LA Southwest College – Square D
 - 6. LA Trade Tech College – Eaton Cutler Hammer, Square D
 - 7. LA Valley College – Eaton Cutler Hammer, GE, Square D
 - 8. West LA College – GE, Eaton, Square D
- C. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.
- D. Insulation system and average winding temperature rise for rated KVA as follows:

<u>Ratings</u>	<u>Class</u>	<u>Rise (degree C)</u>
Less than 15	185	As shown on the drawings
15 or higher	220	As shown on the drawings

- E. Case temperature shall not exceed 40°C rise above ambient at its warmest point.
- F. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
- G. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.
- H. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

- I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- J. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.
- K. Coil Conductors: Continuous windings with terminations brazed or welded.
- L. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.
- M. Isolate core and coil from enclosure using vibration-absorbing mounts.
- N. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.
- O. Ground all transformers as a separately derived system as required by the CEC – California Electrical Code.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Main and distribution switchboards

PART 2 PRODUCTS

2.01 GENERAL

- A. Approved Manufacturers:

- 1. Square D
- 2. General Electric
- 3. Eaton Cutler-Hammer

- B. Campus Standards

- 1. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler-Hammer, Selection to match existing
- 2. LA Harbor College – GE, Eaton Cutler-Hammer, Selection to match existing
- 3. LA Mission College – Square D
- 4. LA Pierce College - Square D, GE Eaton Cutler-Hammer
- 5. LA Southwest College – Square D, Selection to match existing
- 6. LA Trade Tech College – GE, Square D, Selection to match existing
- 7. LA Valley College – GE, Square D, Eaton Cutler Hammer, Match existing
- 8. LA West College – Selection to match existing – GE, Eaton, Square D

2.02 RATINGS

- A. Definitions:

- 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating.
- 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

- B. The switchboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.03 SWITCHBOARD CONSTRUCTION AND RATINGS

- A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.
 - B. Switchboard electrical ratings and configurations as shown on the drawings.
 - C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.
 - D. Main Section Devices: Individually mounted and compartmented.
 - E. Distribution Section Devices: Individually mounted.
 - F. Auxiliary Section Devices: Individually mounted and compartmented.
 - G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.
 - H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.
 - I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.
 - J. The bus shall extend the full height of the distribution sections to provide space for future breakers.
 - K. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.
 - L. Provide metering transformer compartment for Utility Company's use. Compartment size, bus spacing and drilling, door, and locking and sealing requirements shall be in accordance to Section 26 20 00 and Utility Company specifications.
 - M. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear.
 - N. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.
 - O. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
 - P. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.
 - Q. Pull Section: Same construction as switchboard, size as shown on the drawings. Depth and height to match switchboard. Arrange as shown on the drawings.
 - R. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.
 - S. Suitable for use as service entrance equipment.
- 2.04 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION
- A. Fusible Switch Assemblies (600 Amperes and Smaller): Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class 'R' fuses, type as specified, with Class 'R' rejection clips.

- B. Fusible Switch Assemblies (800 Amperes and Larger): Bolted pressure contact switches. Fuse Clips: Designed to accommodate Class L fuses.
- C. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.
- D. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 2,500 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover. Provide stationary mounting. draw-out construction. Ground fault sensing shall be breaker integral with circuit breaker. Provide zero sequence type ground fault sensor. Provide breaker interrupting ratings as indicated on the plans.
- E. Solid-State Insulated Case Circuit Breakers: (All breakers identified on plans as solid state with frame sizes above 2,500 ampere.) Provide insulated case switch with two-step stored energy closing. Provide manual charging handle, and electric charging motor where indicated as electrically operated. Provide with rating plug as required on drawings and electronic circuits for true rms current sensing, timing, and tripping for fully adjustable time current characteristics including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip settings shall be field programmable with a sealable clear cover. Ground fault sensing shall be summation type integral to breaker. Provide stationary mounting. draw-out construction. Provide breaker interrupted ratings as indicated on the plans.
- F. Arc Energy Reduction:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
- G. Arc Energy Reduction with Selective Coordination:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
 - 2. Zone-Selective Interlocking System: Provide a zone-selective interlocking system for the electrical equipment. The system shall provide the following functions:
 - a. Selective coordination
 - b. Permanent arc energy reduction
 - 3. The following arc energy reduction system options are acceptable:
 - a. Zone-selective interlocking with permanent arc energy reduction
 - b. Differential relaying with permanent arc energy reduction
 - c. Listed energy-reducing active arch flash mitigating system

2.05 INSTRUMENTS AND SENSORS

- A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- B. Potential Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Ground Fault Sensor: Zero sequence type.
- D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- E. Double-ended Equipment Ground Fault Protection: Provide a modified differential ground fault protection scheme. Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- F. Electronic Power Monitor: Refer to Section 26 09 13.
- G. Digital AC Power Monitor. Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.

2.06 BUILDING-LEVEL SUB-METERS

- A. LACCD buildings over 10,000 square feet shall have sub-meters installed.
 - 1. All central utility plants in any size structure or any configuration, shall also have sub-meters installed subject to this standard.
- B. Building-level sub-meters shall be configured to interface and exchange data with the district's existing metering software.
- C. Building-level sub-meters shall include an Ethernet communications port or wireless communication capability or other networking capability.
- D. Building level utility sub-meters shall be installed to capture the following data at a minimum of 15-minute intervals:
 - 1. Electricity consumption (kWh)
 - 2. Power demand (kW)
 - 3. Power Factor
- E. Individual Meters shall retain data for a period of no less than 12 months.
- F. Solar photovoltaic arrays installed in or on a building shall have a dedicated meter to track PV productions. This is in addition to the building level sub-meter and must be in compliance with all the requirements outlined in the standards.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Main and Distribution panelboards
- B. Lighting and appliance branch circuit panelboards

PART 2 PRODUCTS

2.01 RATINGS

- A. Definitions:
 - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.
 - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.02 MAIN AND DISTRIBUTION PANELBOARDS

A. General

- 1. Approved Manufacturers:
 - a. Square D
 - b. ABB GE
 - c. Siemens
- 2. Campus Standards
 - a. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler Hammer
 - b. LA Harbor College – GE Eaton Cutler Hammer
 - c. LA Mission College – Square D
 - d. LA Pierce College – Square D
 - e. LA Southwest College – Square D, GE, Eaton Cutler Hammer
 - f. LA Trade Tech College – Square D, GE, Eaton Culter Hammer, Siemens

- g. LA Valley College – GE, Square D, Eaton Cutler Hammer, Siemens
 - h. West LA College – Siemens, Eaton Cutler Hammer, GE, Square D
- B. Panelboards: NEMA PB 1; type as shown on the drawings.
 - C. Enclosure: NEMA PB 1; Type 1 (Indoor type).
 - D. Provide cabinet front with hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Each door shall be equipped flush lock type, spring latching, Yale lock for metal door keyed to a Yale key. All panelboard locks shall be keyed to operate from one key. Finish in manufacturer's standard gray enamel.
 - E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
 - F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.
 - G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.
 - H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
 - I. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.
 - J. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
 - K. Solid State Molded Case Circuit Breakers: All breakers identified on plans as solid-state with 1,200 ampere frame sizes and below. Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time s
 - L. Arc Energy Reduction:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1200 amps or larger.
 - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch at the entrance to the electrical room in the first section of the electrical equipment.
 - M. Suitable for use as service entrance equipment.

2.03 BRANCH CIRCUIT PANELBOARDS

- A. General
 - 1. Approved Manufacturers:

- a. Square D
 - b. General Electric
 - c. Siemens
 - d. Eaton
- B. Campus Standards
- 1. LA Pierce College – All panelboard shall be full size panel with 42 circuits, bolt-on type breaker, with main breaker and ground bus. All space fill with 1-pole 20A breaker and come with lock-kit.
- C. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- D. Enclosure: NEMA PB 1; Type 1 (Indoor type).
- E. Provide cabinet front door in door with hinged trim to allow access to wiring gutters without removal of trim and flush lock all keyed alike. Each door shall be equipped flush lock type, spring latching, Yale lock for metal door keyed to a Yale key. All panelboard locks shall be keyed to operate from one key. Hinged trim shall be secured with screws. Finish in manufacturer's standard gray enamel.
- F. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- G. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- H. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- I. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- J. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- K. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.
- L. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

END OF SECTION

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SECTION 26 24 19

MOTOR CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manual motor starters
- B. Magnetic motor starters
- C. Combination magnetic motor starters
- D. Solid-state reduced voltage motor starters (soft starters)
- E. Motor control centers

PART 2 PRODUCTS

2.01 MANUAL MOTOR STARTERS

- A. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.
- B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
- D. Enclosure: NEMA ICS 6; Type 1.

2.02 MAGNETIC MOTOR STARTERS

- A. Approved Manufacturers:
 - 1. Allen Bradley
 - 2. Siemens (Furnas)
 - 3. Square D
 - 4. General Electric
- B. Campus Standards
 - 1. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler Hammer
 - 2. LA Harbor College – GE, Eaton Cutler Hammer

3. LA Mission College – Square D
 4. LA Pierce College – Square D, GE, Eaton Cutler Hammer
 5. LA Southwest College – Square D
 6. LA Trade Tech College – Square D
 7. LA Valley College – GE, Square D, Eaton Cutler Hammer
 8. West LA College – GE, Eaton , Square D
- C. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- D. Full Voltage Starting: Non-reversing type, unless otherwise indicated.
- E. Reduced Voltage Starting: Closed-circuit transition wye-delta type: NEMA ICS 2, closed transition with adjustable time delay.
- F. Two Speed Starting: Two speed, one winding, variable torque type. NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.
- G. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.
- H. Size: NEMA ICS 2; size as shown on the drawings.
- I. Overload Relay:
1. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 20 30 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 20 30 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- J. Enclosure: NEMA ICS 6; Type 1.
- K. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.
- L. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.
- M. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- N. Elapsed Time Meters: Heavy duty with readout in tenths of an hour.
- O. Indicating Lights: NEMA ICS 2; RUN: red in front cover.
- P. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- Q. Relays: NEMA ICS 2.

- R. Control Power Transformers: 120 volt fused secondary, fused primary; minimum VA as scheduled:
 - 1. Size 1 - 100 VA
 - 2. Size 2 - 100 VA
 - 3. Size 3 - 150 VA
 - 4. Size 4 - 300 VA
 - 5. Size 5 - 300 VA
 - 6. Size 6 - 300 VA
- S. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

2.03 SOLID-STATE REDUCED VOLTAGE MOTOR STARTERS (SOFT STARTERS)

- A. Approved Manufacturers:
 - 1. Allen Bradley
 - 2. Siemens (Furnas)
 - 3. Square D
 - 4. General Electric
- B. Campus Standards
 - 1. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler Hammer
 - 2. LA Harbor College – Eaton Cutler Hammer
 - 3. LA Mission College – Square D
 - 4. LA Pierce College – Square D, GE, Eaton Cutler Hammer, Siemens
 - 5. LA Southwest College – Square D, GE, Eaton Cutler Hammer
 - 6. LA Trade Tech College – GE, Square D, Siemens,
 - 7. LA Valley College – GE, Square D, Cutler Hammer, Siemens
- C. Soft Starters: ANSI/UL Standard 508. Used with NEMA Design B, AC induction motors to reduce in-rush current and mechanical shocks associated with starting and stopping motors.
- D. Operation: The soft starter shall utilize a thyristor (SCR) bridge to control the starting and stopping of the motor. A microprocessor shall monitor the current and control the phasing of the SCRs. The soft starter shall provide torque control for linear acceleration without external feedback independent of motor load or motor application.
- E. Torque ramp: Adjustable (by keypad) from 1 to 60 seconds.
- F. Shorting Contactor: A shorting contactor shall be supplied with all soft starters rated above 40 amps. The shorting contactor shall close after the current is below 130% of motor full-load amps at the nominal voltage. The shorting contactor shall open on a stop command to allow a deceleration ramp, if applicable.
- G. Status & Diagnostics: Door-mounted keypad for display of soft starter, motor, and fault statuses.

- H. Motor Protection against Solid-State Component Failure: Provide an isolation contactor that opens when the motor is stopped or when the controller detects a fault condition such as a shorted thyristor.
- I. Over-Current Protection Device / Power Disconnect: Integral molded case disconnect switch and in-line fuse block for RK type power fuses (up to 600 amps). Short circuit current rating shall be 65,000 AIC minimum or as indicated on drawings.
- J. Overcurrent Condition: The soft starter shall be capable of supplying 300% of rated full load current for 30 seconds at maximum ambient temperature.
- K. Electronic Protective Features: Thermal overload protection, phase reversal protection, stall protection, locked rotor protection, and underload protection. The display shall also indicate a starter thermal fault, phase fault, frequency fault, external fault, maximum start time exceeded, serial link fault, and internal failure.
- L. Controls: The control circuitry shall be fed internally from the line supply, completely independent of the power circuit and separate from the control logic. The control circuitry shall operate at 120 VAC via an integral control power transformer.
- M. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- N. Input: Remote control start/stop signal, and one logic input for force to freewheel, indication of external fault, force to local control, or remote overload reset.
- O. Outputs: Isolation contactor status, torque ramp status, overload pre-alarm, fault alarms, and one field convertible auxiliary contact. One analog output shall be available for 4-20mA indication of motor current, torque, thermal state, or power factor.
- P. Current and Horsepower Ratings: As indicated in the Starter/Disconnect Schedule on the drawings.
- Q. Input/Output Voltage: As indicated in the Starter/Disconnect Schedule on the drawings. The controller shall be capable of operating between -15% to +10% of nominal voltage rating.
- R. Environmental Characteristics: Ambient Air Temperature: 0°C to 40°C; Maximum Relative Humidity: 93% (non-condensing); Minimum Elevation without Derating: 3300 feet.
- S. Enclosure: NEMA ICS 6; Type 1, with provisions for padlocking the door.

2.04 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

- A. Molded Case Thermal-Magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- B. Non-fusible Switch Assemblies: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

Campus Standards

1. LA Harbor College – General Electric (GE)
2. LA Trade Tech College – General Electric (GE), Square D

- C. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

2.05 MONITORING AND METERING

- A. The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20mA analog signal (kW) to the Facility Management and Control System (FMCS) to monitor the power consumption.
- B. Starter must be capable of communicating over BACnet. At a minimum, reported points shall include starter mode, terminal input status, run/fault status, voltage, current, power factor, kW and kWh.

2.06 MOTOR CONTROL CENTER

- A. Approved Manufacturers:
 - 1. Square D
 - 2. ABB (General Electric)
 - 3. Siemens
- B. Campus Standards
 - 1. East LA College and Southgate Environmental Center – Square D, GE, Eaton Cutler Hammer
 - 2. LA Harbor College – Square D
 - 3. LA Mission College – Square D
 - 4. LA Pierce College – Square D, GE, Eaton Cutler Hammer
 - 5. LA Southwest College – Square D, GE, Eaton Cutler Hammer
 - 6. LA Trade Tech College – Square D
 - 7. LA Valley College – GE, Square D, Eaton Cutler Hammer
 - 8. West LA College – Selection to match existing, GE, Eaton Cutler Hammer Square D
- C. Motor Control Centers: NEMA ICS 2; Class 1, Type B.
- D. Main Overcurrent Protection: As shown on the drawings.
- E. Motor Controllers: As scheduled or indicated on the drawings.
- F. Feeder Tap Units: Circuit Breakers.
- G. Voltage Rating: 480/277 volts, 3-phase, 4-wire, 60 Hertz.
- H. Horizontal Bussing: Copper, with a continuous current rating of 600 amperes. Include copper ground bus entire length of control center.
- I. Vertical Bussing: NEMA ICS 2; copper.

- J. Integrated Equipment Short Circuit Rating: As indicated on the drawings.
- K. Configuration: Units front mounting only, accessible from the front only.
- L. Enclosure: NEMA 250; Type 1, unless noted otherwise.
- M. Finish: Manufacturer's standard gray enamel.
- N. Provide phase loss protection relay with contacts to de-energize each motor starter in control center.
- O. Control Transformers: Provide individual fused control transformers in the motor control center to provide independent 120-volt control source for each motor controller in the control center.

END OF SECTION

SECTION 26 27 13
ELECTRICITY METERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electricity Meters.

PART 2 PRODUCTS

2.01 UTILITY METERING INFRASTRUCTURE

- A. Install metering accessories furnished by utility company, complying with its requirements.
- B. Utility-furnished meters.
- C. Current-transformer cabinets.
- D. Meter sockets.
- E. Modular Meter Center: Factory-coordinated assembly of main service disconnect device, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
 - 1. Housing: UL 50E, Type 3R enclosure.
 - 2. Minimum Short-Circuit Rating: 65 000 A symmetrical at rated voltage.
 - 3. Main Disconnect Device: Circuit breaker.
 - 4. Surge Protection:
 - a. Factory-installed in main disconnect.
- F. Arc-flash warning labels.

2.02 ELECTRICITY METERS

- A. General Requirements for Meters:
 - 1. Billing Meters Accuracy: 0.5 percent of reading, complying with NEMA ANSI C12.20.
 - 2. Meters Certification: Certified by California Type Evaluation Program as complying with 4 CCR 4027, Article 2.2.
 - 3. Enclosure: Supplied by meter manufacturer, UL 50E, Type 3R minimum, with provisions for locking or sealing.
 - 4. Sensors:
 - a. Type: Split and solid core, complying with recommendation of meter manufacturer.

- B. kWh Meter: Electronic single-phase and three-phase meters, measuring electricity use.
 - 1. Display: LCD.
- C. kWhd Meter: Electronic single-phase and three-phase meters, measuring electricity use and demand. Demand must be integrated over 15-minute interval.
- D. KY and KYZ pulse totalizer.
- E. Remote Reading Options:
 - 1. Pulse Output: KYZ, complete with optical sensor and interface devices.
 - 2. TIA-485 serial interface, with Modbus RTU protocol.
 - 3. USB interface.
 - 4. TCP/IP adapter.
- F. Current-transformer cabinet.
- G. Uninterruptible Power Supply: Single phase, 120 V(ac), sized and rated to provide continuous power to meter for operations of 48 hours after interruption of normal power.
- H. Software: PC-based product recommended by meter manufacturer, suitable for calculating utility cost allocation.

END OF SECTION

SECTION 26 27 16

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hinged cover enclosures
- B. Cabinets
- C. Terminal blocks and accessories

PART 2 PRODUCTS

2.01 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250; Type 1, 3R, 4, 14 gauge steel.
- B. Finish: Manufacturer's standard polyester powder paint finish.
- C. Covers: Continuous hinge with stainless steel hinge pin. Covers longer than 24 inches shall have 3-point latching.
- D. Locks: Flush 1/4 turn cylinder key latch 3-point latch kit with padlock handle quick-release latch.
- E. Provide interior white painted metal panel for mounting terminal blocks and electrical components.

2.02 CABINETS

- A. Cabinet Boxes: Galvanized steel with removable end walls dimensions as indicated on the drawings.
- B. Cabinet Fronts: Steel, flush surface type with screw cover front, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.03 TERMINAL BLOCKS AND ACCESSORIES

- A. Terminal Blocks: ANSI/NEMA ICS 4; UL listed.
- B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts.

2.04 FABRICATION

- A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.
- B. Provide conduit hubs or knockouts on enclosures.
- C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Device plates and box covers
- B. Modular connectors
- C. Receptacles
- D. Countertop and furniture receptacle assemblies
- E. Pin and sleeve devices
- F. Floor boxes
- G. Service fitting
- H. Pedestal style box
- I. Poke-through fittings
- J. Pendant cord/connector devices
- K. Cord and plug sets
- L. Cord reel

PART 2 PRODUCTS

2.01 DEVICE COLOR

- A. All switch, receptacle, outlet, and cover plate colors shall be verified with Architect, unless indicated otherwise.

2.02 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
 - 1. Campus Standards (Verify for acceptance of other coverplate types for specific spaces noted on item 2 through 5 below.)
 - a. East LA College and Southgate Environmental Center – Stainless finish plates
 - b. LA Harbor College – Stainless finish plates
 - c. LA Mission College – Stainless
 - d. LA Pierce College – Stainless, Permanently etched circuit # and panel #.

- e. LA Southwest College – Stainless finish plates
 - f. LA Valley College - Stainless finish plates (engraved on the front)
 - g. West LA College – Stainless 302
 - h. Stainless steel coverplates shall be Leviton (LACCD standard).
- 2. Unbreakable thermoplastic/thermoset plastic cover plates in finished spaces where walls are finished.
 - 3. Decorator thermoplastic wall plates in public finished spaces where walls are finished. Approved Manufacturer: Leviton Decora, Hubbell Decorator, Cooper Decorator, or approved equal.
 - 4. Decorator Snap-On nylon or polycarbonate wall plates with sub-base in public finished spaces. Approved Manufacturer: Leviton 803##, Hubbell RCW, Cooper PJS, Pass & Seymour SWP or approved equal.
 - 5. Type #302 stainless steel cover plates in unfinished spaces for flush boxes with permanently etched on panel name and circuit number. Approved Manufacturer: Leviton.
 - 6. Galvanized steel cover plates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the cover plate shall be of the ganged style for the number of devices used.
 - C. Install nameplate identification as indicated in Section 26 05 53.
 - D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.03 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. Devices that are shaded on the drawings shall be red.
- C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.
- D. NEMA 5-20R Duplex Receptacle:
 - 1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
 - 2. Approved Manufacturers: Hubbell 5352A, Leviton, 5362-S, Pass & Seymour 5362, Cooper 5352.
 - 3. Provide decorative style duplex receptacles in public spaces where walls are finished.
 - 4. Approved Manufacturers: (Decorative), Hubbell, Leviton, Pass & Seymour, Cooper.
 - 5. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap.
 - 6. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.

7. Campus Standards
 - a. LA Harbor College – Leviton, Hubbell
 - b. LA Trade Tech College – Leviton, Hubbell
8. 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.
9. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
10. NEMA 5-20R Ground Fault Duplex Receptacle:
11. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
12. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
13. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- E. NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
 1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use cast aluminum cover.
 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 3. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- F. NEMA 5-20R Isolated Ground Duplex Receptacle:
 1. 125-volt, 20 amp, 3-wire grounding type with orange impact resistant thermoplastic face. Orange cover plate with 'Isolated Ground' stenciled in black.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- G. NEMA 5-20R Isolated Ground and Surge Suppression Duplex Receptacle:
 1. 125-volt, 20 amp, 3-wire grounding type with orange impact resistance thermoplastic face, light, and alarm. Orange cover plate with 'Isolated Ground' stenciled in black.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- H. NEMA 5-20R Double Duplex Isolated Ground and Surge Suppression Receptacle:
 1. Consists of two duplex isolated ground and surge suppression receptacles, double gang box, plaster ring and faceplate.
 2. Approved Manufacturers: Refer to Isolated Ground and Surge Suppression Receptacle above.
- I. NEMA 5-20R Receptacle with USB Charger:
 1. 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Type A USB charging rated at 5VDC 2.1A. Mounted in double gang backbox.

2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.
 3. 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. One Type A USB charging rated at 5VDC 2.1A. One Two Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.
 4. Approved Manufacturers: Hubbell
- J. NEMA 5-20R Simplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, , Pass & Seymour, Cooper.
- K. NEMA 5-30R Simplex Receptacle:
1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper 5716N.
- L. NEMA 5-50R Simplex Receptacle:
1. 125-volt, 50 amp, 3-wire grounding type, phenolic face.
 2. Approved Manufacturers: Hubbell, Cooper.
- M. NEMA 6-20R Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper 5461.
- N. NEMA 6-30R Simplex Receptacle:
1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- O. NEMA 6-50R Simplex Receptacle:
1. 250-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- P. NEMA 7-20R Simplex Receptacle:
1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour.
- Q. NEMA 7-30R Simplex Receptacle:
1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.

- R. NEMA 7-50R Simplex Receptacle:
1. 277-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- S. NEMA 14-20R Simplex Receptacle:
1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.
- T. NEMA 14-30R Simplex Receptacle:
1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +24 AFF.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- U. NEMA 14-50R Simplex Receptacle:
1. 125/250-volt, 50 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +4" AFF.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- V. NEMA 14-60R Simplex Receptacle:
1. 125/250-volt, 60 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- W. NEMA 15-20R Simplex Receptacle:
1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- X. NEMA 15-30R Simplex Receptacle:
1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- Y. NEMA 15-50R Simplex Receptacle:
1. 250-volt, 50 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- Z. NEMA 15-60R Simplex Receptacle:
1. 250-volt, 60 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.

- AA. NEMA L5-20R Simplex Receptacle, Locking Type:
1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- BB. NEMA L5-30R Simplex Receptacle Locking Type:
1. 125-volt, 30 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- CC. NEMA L6-20R Locking Type Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- DD. NEMA L6-30R Locking Type Simplex Receptacle:
1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- EE. NEMA L7-20R Locking Type Simplex Receptacle:
1. 277-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- FF. NEMA L7-30R Locking Type Simplex Receptacle:
1. 277-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- GG. NEMA L14-20R Locking Type Simplex Receptacle:
1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.
- HH. NEMA L14-30R Locking Type Simplex Receptacle:
1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- II. NEMA L15-20R Locking Type Simplex Receptacle:
1. 250-volt, 20 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- JJ. NEMA L15-30R Locking Type Simplex Receptacle:

1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- KK. NEMA L16-20R Locking Type Simplex Receptacle:
1. 480-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.
- LL. NEMA L16-30R Locking Type Simplex Receptacle:
1. 480-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- MM. NEMA L21-20R Locking Type Simplex Receptacle:
1. 120/208Y 3 phase 20-amp 5 wire grounding type.
 2. Approved Manufacturers: Hubbell, Cooper, Pass & Seymour.
- NN. NEMA L21-30R Locking Type Simplex Receptacle:
1. 120/208Y 3 phase 30-amp 5 wire grounding type.
 2. Approved Manufacturers: Hubbell, Cooper, Pass & Seymour.
- OO. NEMA 5-20R Tamper Resistant Duplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
 2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
 3. Provide decorative style duplex tamper resistant receptacles in public spaces where walls are finished.
 4. Approved Manufacturers: (Decorative), Hubbell, Leviton, Pass & Seymour.
- PP. NEMA 5-20R GFI Tamper Resistant Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type tamper-resistant with test and reset buttons in impact resistant thermoplastic face.
 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 3. Approved Manufacturers: Hubbell, Cooper, Pass & Seymour, Leviton.
- QQ. NEMA 5-20R Double Duplex Tamper Resistant Receptacle:
1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.
 2. Approved Manufacturers: Refer to Tamper Resistant Receptacle above.

RR. NEMA 5-20R Plug Load Controlled Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap. Bottom half of duplex shall be split circuit wired and controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and NEC 2014 compliant marking on face of device.
2. Approved Manufacturers: Pass & Seymour, Leviton, Hubbell, Cooper.

SS. NEMA 5-20R Plug Load Controlled Duplex Receptacle:

1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.
2. Approved Manufacturers: Refer to Plug Load Controlled Duplex Receptacles above.

TT. NEMA 5-20R Double Duplex Receptacle:

1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
2. Approved manufacturers: Refer to Duplex Receptacle above.

UU. NEMA 5-20R Double Duplex GFI Receptacle:

1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
2. Approved Manufacturers: Refer to Duplex GFI Receptacle above.

VV. NEMA 5-20R Double Duplex USB Receptacle:

1. Consists of two duplex USB receptacles, double gang box, plaster ring and faceplate.
2. Approved Manufacturers: Refer to USB Receptacle above.

WW. NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:

1. Consists of two duplex, GFI receptacles. Double gang box. Provide NEMA 3R rated while-in-use cast aluminum cover.
2. Approved Manufacturers:
 - a. Receptacle: Refer to GFCI Receptacle above.
 - b. Cover: Intermatic, Pass & Seymour, Thomas & Betts.

XX. 600-volt, 60 amp, 3-pole, 4-wire Locking Type Simplex Receptacle for X-ray Isolated Power Equipment:

1. Black nylon or polycarbonate face. Cast aluminum surface mounted box, 45° angle adapter, weather protective lift cover on receptacle.
2. Approved Manufacturers: Hubbell, Pass & Seymour, Cooper.

YY. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

- ZZ. Side wired devices shall have four binding screws that are undercut for positive wire retention.
- AAA. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.
- BBB. Isolated ground receptacles shall have the equipment ground contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from the mounting strap.
- CCC. Integral surge suppression receptacles with integral surge suppression shall comply with the following:
1. Category A3 listed.
 2. Line to ground, line to neutral, and neutral to ground modes.
 3. Metal-oxide varistors with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 210 joules per mode.
 4. Status indication: Light visible in the face of the device and audible alarm to indicate device is no longer active or in service.
 5. Distinctive symbol on device face to denote SPD-type device.
 6. Device shall be blue with stainless cover plate.
 7. NEMA 5-20R duplex receptacle, 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap.
 - a. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour, Cooper.
- DDD. Hazardous (Classified) location receptacles shall comply with NEMA FB 11.

2.04 PIN AND SLEEVE DEVICES

- A. Industrial heavy-duty pin and sleeve devices shall comply with IEC 309-1.
1. IEC rated pin and sleeve watertight IP67 receptacle, raintight screw cap with safety chain and matching plug.
- B. 120/208 277/480-volt, 30 amp, 3-pole, 4-wire Pin and Sleeve Receptacle:
1. Approved Manufacturers: Hubbell, Pass and Seymour, Cooper, Leviton
- C. 120/208 277/480-volt, 60 amp, 3-pole, 4-wire Pin and Sleeve Receptacle:
1. Approved Manufacturers: Hubbell, Pass and Seymour, Cooper, Leviton
- D. 120/208 277/480-volt, 100 amp, 3-pole, 4-wire Pin and Sleeve Receptacle:
1. Approved Manufacturers: Hubbell, Pass and Seymour, Cooper, Leviton
- E. 480-volt, 60 amp, 4-pole, 4-wire Pin and Sleeve Simplex Receptacle:

1. Surface-mount enclosure with 15° mounting box, 1-1/2" conduit hub, raintight screw cap with safety chain.
 2. Approved Manufacturers: Appleton, Crouse-Hinds.
- F. 480-volt, 100 amp, 4-pole, 4-wire Pin and Sleeve Simplex Receptacle:
1. Surface-mount enclosure with 15° mounting box, 2" conduit hub.
 2. Approved Manufacturers: Appleton, Crouse-Hinds, Killark.
- G. 600-volt, 30 amp, 3-phase, 3-wire Pin and Sleeve Simplex Receptacle:
1. Provide with raintight, weatherproof enclosure.
 2. Approved Manufacturers: Appleton, Crouse-Hinds, Killark.

2.05 FLOOR BOXES

- A. Color: Verify with Architect.
- B. Coordinate with Technology drawings for voice/data outlet requirements.
- C. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Fully adjustable, cast iron.
- D. Flush-mounted, round, cast iron floor box with one (1) fully adjustable, round brass cover with duplex flap cover and brass carpet flange.
1. Approved Manufacturers:
 - a. Hubbell
 - b. Wiremold
 - c. Steel City
- E. Fully adjustable cast iron floor box, dual compartment, flush mount, brass carpet flange. One compartment with brass 2-1/8" x 3/4" combination cover for power connections to partitions by others, connection wire by EC. One compartment with brass 1-1/2" x 1-1/2" duplex thread cover with one (1) 3/4" and one (1) 1" conduit stubbed to above the lay-in ceiling routed to the corridor cable tray.
1. Approved Manufacturers:
 - a. Hubbell
 - b. Wiremold
 - c. Steel City
- F. Cast iron floor box, dual compartment, flush mount, brass carpet flange. One compartment with one (1) brass duplex flap cover. One compartment with brass 2-1/8" x 3/4" combination cover and one (1) 3/4" and one (1) 1" conduit stubbed to above the lay-in ceiling routed to the corridor cable tray.
1. Approved Manufacturers:
 - a. Hubbell

- b. Wiremold
 - c. Steel City
 - G. Recessed multi-service floor box - tele/power/data. Equivalent mounting space of four (4) single gang boxes consisting of one (1) **[REC-DUP]**, one (1) voice outlet, one (1) data outlet, and one (1) spare. Cast iron adjustable rectangular floor box with cover. Provide one (1) 1" conduit for information outlet cabling, one (1) 1" conduit for audio/visual cabling, and one (1) 1" conduit as spare. Route low voltage cabling conduits to above the lay-in ceiling the corridor cable tray.
 - 1. Approved Manufacturers:
 - a. Wiremold RFB4-CI
 - b. Steel City 665-CI
 - c. Hubbell LCFBCA
 - H. Three service floor box - tele/power/data. Equivalent mounting space of four (4) single gang boxes consisting of one (1) voice outlet, one (1) data outlet, and one (1) spare. Steel adjustable rectangular floor box with flush cover. Provide one (1) 1" conduit for information outlet cabling, one (1) 1" conduit for audio/visual cabling, and one (1) 1" conduit as spare. Route low voltage cabling conduits to above the lay-in ceiling the corridor cable tray.
 - 1. Approved Manufacturers:
 - a. Wiremold
 - b. Steel City
 - c. Hubbell
- 2.06 SERVICE FITTING BOX
- A. Service fitting style box with 1" chase nipple. Two (2) **[REC-DUP]**. Install back to back in box.
 - 1. Approved Manufacturers:
 - a. Hubbell
 - b. Steel City
 - B. Cast aluminum service fitting style box mounted to underfloor duct. one (1) **[REC-DUP]**.
 - 1. Approved Manufacturers:
 - a. Walker Duct
 - b. Square D
 - c. Thomas & Betts
- 2.07 PEDESTAL STYLE BOX
- A. Cast aluminum pedestal style box with 1" hub. One (1) **[REC-DUP]**. Install back to back in box. Provide stainless steel cover plates.
 - 1. Approved Manufacturers:
 - a. Hubbell
 - b. Thomas & Betts

- B. Cast aluminum pedestal style box with 1" hub. Two (2) **[REC-DUP]**. Install back to back in box. Provide stainless steel cover plates.
 - 1. Approved Manufacturers:
 - a. Hubbell
 - b. Thomas & Betts

2.08 POKE-THROUGH FITTINGS

- A. UL listed as fire-rated poke-through device for 1, 1-1/2 and 2 hour rated floors: include fire stops and smoke barriers in through-floor component. UL514A listed for scrub locations.
- B. Terminate in 4-inch square by 2-1/2-inch deep junction box.
- C. Suitable for installation with a floor thickness of 2-1/4 to 7 inches.
- D. Semi-flush die-cast aluminum carpet flange.
- E. Spring loaded receptacle covers.
- F. Verify color with Architect.
- G. Fire Rated Poke-Through:
 - 1. Flush mounted. For use with 3-inch core holes. 125-volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4" conduit and junction box. Provide with two (2) data jacks. With painted aluminum solid brass flange.
 - 2. Approved Manufacturers: Hubbell, Wiremold, Thomas & Betts.
- H. Fire Rated Poke-Through:
 - 1. Flush mounted. For use with 4-inch core holes. Provide with _____ 125-volt, 20 amp, NEMA 5-20R duplex receptacles with 3/4" conduit and junction box. Provide with capacity for six data jacks and oversized conduit, with solid brass flange.
 - 2. Cast aluminum cover with separate hinged doors to open 180°. Finish as selected by Architect.
 - 3. Approved Manufacturers: Hubbell, Wiremold, Thomas & Betts.
- I. Fire-Rated Multi-Service Recessed Poke-Through:
 - 1. Recessed mounted. For use with 6-inch core holes. Provide with two 125-volt, 20 amp, NEMA 5-20R duplex receptacles with 3/4" conduit and junction box. Provide with capacity for eight data jacks and 2" conduit.
 - 2. Cast aluminum cover with separate hinged doors to open 180°. Finish as selected by Architect.
 - 3. Approved Manufacturers: Hubbell, Wiremold.
- J. Fire-Rated Multi-Service Recessed 8" Poke-Through:

1. Recessed mounted. For use with 8-inch core holes. Provide with two (2) 125-volt, 20 amp, NEMA 5-20R duplex receptacles with 3/4" conduit and junction box. Provide with capacity for 12 data jacks and 2" conduit.
2. Cast aluminum cover with separate hinged doors to open 180°. Finish as selected by Architect.
3. Approved Manufacturers: Hubbell, Wiremold.

2.09 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade or refer to Details as shown on drawings.
1. Body: Nylon with screw-open cable gripping jaws and provisions for attaching external cable grip.
- B. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.10 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

2.11 CORD REELS

- A. 50' 3#12 AWG type 'SOW-A' cord with adjustable ball stop. 120 volt, NEMA 5-20R, simplex receptacle connector, rated 16 amps continuous.
1. Approved Manufacturers:
 - a. Daniel Woodhead w/ Hubbell 5369
 - b. Appleton
 - c. Hubbell
- B. 50' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Hand lamp with simplex 120-volt NEMA 5-15R receptacles, rated 6.5 amps.
1. Approved Manufacturers:
 - a. Daniel Woodhead
 - b. Appleton
 - c. Hubbell
- C. 25' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Two 120-volt NEMA 5-15R receptacles mounted in cast outlet box, rated 10 amps.

1. Approved Manufacturers:
 - a. Daniel Woodhead
 - b. Appleton
 - c. Hubbell

END OF SECTION

SECTION 26 27 29

ELECTRIC VEHICLE CHARGING STATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electric vehicle charging stations:
- B. Electric vehicle radio frequency identification (RFID) card system

1.02 REFERENCES

- A. CBC – California Building Code
- B. ADA – Americans with Disabilities Act
- C. The equipment and components in this specification shall be designed and manufactured according to the latest revision of the following standards (unless otherwise noted):
 - 1. SAE J1772 Standard for Electric Vehicle Conductive Charge Coupler
 - 2. NFPA 70 Article 625 Electric Vehicle Charging Systems
 - 3. UL 2202, Electric Vehicle (EV) Charging System Equipment
 - 4. UL 2231, Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits
 - 5. UL 2251, Plugs, Receptacles and Couplers for Electric Vehicles
 - 6. UL 2594, Electric Vehicle Supply Equipment
 - 7. UL and cUL listed
 - 8. ISO 15693

1.03 DESIGN CRITERIA

- A. The project must provide electric vehicle supply equipment (EVSE) for at least 25% of all parking spaces including accessible EVCS for each type of charging capacity. EVSE shall be provided as required per regulations. Clearly identify and reserve these parking spaces for the sole use by plug-in vehicles. Accessible parking spaces shall not be used as charging spaces.
 - 1. Provide a Level 2 charging capacity (208 – 240 volts) or greater for each required space.
 - 2. Comply with the relevant regional or local standard for electrical connectors, such as SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler or IEC 62196 of the International Electrotechnical Commission for projects outside the U.S.
 - 3. Meet the connected functionality criteria for ENERGY STAR certified for EVSE and be capable of responding to time-of-use market signals (e.g., price). Projects pursuing WA credit Grid Harmonization should incorporate EVSE into any demand response program or load flexibility and management strategies.

1.04 SUBMITTALS

- A. Submit product data.

- B. Provide product data showing configurations, finishes, dimensions, cable, and coupling information.
- C. Provide manufacturer installation, operation, and maintenance instructions.
- D. Cellular Network and Gateway Plan: Submit manufacturer cellular network and gateway site plan for RFID and revenue generation communication. The manufacturer site plan shall clearly identify the following:
 - 1. Location of gateway enabled stations
 - 2. Location of non-gateway enabled stations
 - 3. Manufacturer approval of gateway and non-gateway enabled stations to ensure unobstructed communication between stations types
- E. Submit RFID software, hardware, and RFID card information.

1.05 SPARE PARTS

- A. Provide RFID cards: 50

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's installation and maintenance manuals.
- B. Contractor shall inspect and report for damage.
- C. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.
- D. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish.

PART 2 PRODUCTS

2.01 ELECTRIC VEHICLE CHARGING STATION

- A. Plan Identification:
 - 1. Electric vehicle charging station, single port type.
 - 2. Electric vehicle charging station, single port type, with network gateway to communicate with non-gateway enabled devices.
 - 3. Electric vehicle charging station, dual port type.
 - 4. Electric vehicle charging station, dual port type, with network gateway to communicate with non-gateway enabled devices.
- B. Approved Manufacturers:
 - 1. Single/Dual Port Charging Station Pedestal Style:
 - a. Square D EVlink
 - b. Leviton EVR Green 4000
 - c. Siemens EV Charging

- d. General Electric DuraStation
 - e. Bosch EL series
 2. Single Port Charging Station Wall-Mounted Style
 - a. Square D EVlink
 - b. Leviton ECR Green 4000
 - c. Siemens EV Charging
 - d. General Electric DuraStation
 - e. Bosch EL Series
- C. Electric vehicle (EV) charging station, Level 2 charging, with LCD display, LED display for charging status, fault indication, power available, internal ground fault protection 20mA, integrated single phase revenue grade meter, anti-nuisance tripping, and re-closure feature.
 1. Enclosure Construction: NEMA 3R or 4X
 2. System Supply: 40 amp, 208-volt, single phase, 60Hz dedicated circuit.
 3. Cable / Connector: Flexible, 25ft, with SAE J1772 compliant connector. Provide complete with cable/connector support while not in use bracket.
 4. Environment: Wet location, -22°F to 122°F
- D. Electronics - Communication:
 1. Wi-Fi / wireless cellular network connection
 2. Ethernet Network Gateway: Provide identified station with network gateway when applicable.
- E. Credit Card Revenue Generation:
 1. Provide integral ChargePoint card / contactless credit card interface.
 2. The Owner will enter into a contract with a revenue service plan. The contractor shall provide provisions to coordinate and set up the revenue service plan on behalf of the Owner.
- F. RFID System Revenue Generation:
 1. Provide EVCS with integral radio frequency identification (RFID) reader.
 2. Provide manufacturer RFID software and RFID reader for customer programming of RFID cards.
 3. Provide RFID cards: Refer to spare parts.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide concrete pad and mow apron for pedestal installation.
- B. Placement:
 1. Verify field measurements with civil and architectural plans.

2. Install pedestal 12 inches behind concrete curb / paving limits or as directed by the manufacturer.
 3. Center pedestal in site islands 24 inches or less in width.
 4. Center dual port pedestals between parking stalls. Align with vehicle parking lines.
- C. Grounding Rod: Provide 5/8 x 10'-0" copper clad steel ground rod for each pedestal, installed 12 inches below finished grade. Provide bare #6 ground wire with exothermic weld for bonding to EVCS pedestal.
- D. Labeling: Provide panel and circuit label for all circuits serving the electric vehicle charging station. Locate circuit labels on the inside utility access cover for the charging station.
- E. Ethernet Connections: Provide final Ethernet cable and terminations per manufacturer instructions.
- F. Cellular Network: Provide setup, testing, and configuration of cellular network per manufacturer instructions.
- 3.02 OWNER TRAINING AND SYSTEM COMMISSIONING:
- A. Provide factory representative for Owner training and demonstration of the system. Owner training shall include service, maintenance, troubleshooting, and general operation of system. The factory representative shall also provide customer in-person training/support for the following:
1. RFID software setup on customer computer
 2. Training for RFID card program
 3. Cellular network registration, initialization, and testing

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable frequency drives

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ABB (General Electric)
- B. Danfoss
- C. Square D
- D. Campus Standards
 - 1. East LA College and Southgate Environmental Center – ABB, Toshiba, Square D
 - 2. LA Mission College – ABB
 - 3. LA Pierce College – ABB
 - 4. LA Southwest College – ABB
 - 5. LA Valley College – ABB, Danfoss, Toshiba, Square D
 - 6. West LA College – ABB, Danfoss

2.02 DESCRIPTION

- A. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.
- B. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.
- C. Controller shall have the functional components listed below:
 - 1. Door interlocked input circuit breaker/fused switch.
 - 2. Input rectifier section to supply fixed DC bus voltage.
 - 3. Smoothing reactor for DC bus.
 - 4. DC bus capacitors.

5. Control transformer.
6. Separate terminal blocks for power and control wiring.
7. Terminal block for operator controls.
8. Sine weighted PWM generating inverter section.

2.03 RATINGS

- A. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- B. Operating Ambient: 0°C to 40°C.
- C. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
- D. Minimum Elevation without Derating: 3300 feet.
- E. Minimum Efficiency at Full Load: 96 percent.
- F. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
- G. Starting Torque: 100 percent of rated torque or as indicated.
- H. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.04 DESIGN

- A. Pulse Width Modulated (PWM) Variable Frequency Drives:
 1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.
 2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.
 3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.
 4. Pulse width modulated (PWM) drives shall be supplied with drive input line reactors with a minimum impedance of 3%. Reactors shall be installed to filter entire drive input circuit.
 5. Pulse width modulated (PWM) drives shall be supplied with drive input harmonic filter to reduce the total harmonic distortion to less than the IEEE519-1992 limits at the utility service entrance.
 6. Drives that are located beyond the manufacturer's recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.
- B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

- C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.
- D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.05 PRODUCT FEATURES

- A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current).
- B. Protection:
 - 1. Input transient protection by means of surge suppressors.
 - 2. Snubber networks to protect against malfunctions due to system transients,
 - 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 - 4. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 20 30 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
 - 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - 6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
 - 7. Loss-of-phase protection.
 - 8. Reverse-phase protection.
 - 9. Short-circuit protection (fuses or circuit breaker).
 - 10. Motor overtemperature fault.
- C. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- D. Deceleration Rate Adjustment: 1 - 30 seconds.
- E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.
- F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.
- G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.
- I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

- K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Set-point frequency (Hz).
 10. Motor output voltage (V).

- S. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
 4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
- U. Three- Contactor Automatic Bypass:

1. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
2. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.
3. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.
4. Provide a Drive-Bypass Selector Switch.
5. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.

V. Control:

1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door.
2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass.
6. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.06 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. All VFD supplied for fans shall have dynamic or DC injection braking capability to provide a means of rapid deceleration of the AC motor in not more than one (1) minute. Adjust controls to stop the motor within 30 seconds.
- C. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds.
- D. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- E. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

- F. Control Relays: Auxiliary and adjustable time-delay relays.
- G. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- H. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- I. Fabrication:
 - 1. Enclosure: NEMA 250, Type 1.
 - 2. Finish: Manufacturer's standard enamel.

END OF SECTION

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SECTION 26 31 00

PHOTOVOLTAIC COLLECTORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Photovoltaic Collectors.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and a distributed network.
 - 1. System Components:
 - a. PV modules.
 - b. Array frame.
 - c. Utility-interactive inverter.
 - d. Overcurrent protection, disconnect, and rapid shutdown devices.
 - e. Mounting structure.
 - f. Utility meter.
- B. Hybrid PV System: Collectors connected to provide power to dc and ac loads, connected to utility through interactive inverters or meters, and connected to energy storage.
 - 1. System Components:
 - a. PV modules.
 - b. Array frame.
 - c. Charge controller.
 - d. Energy storage.
 - e. System control.
 - f. Inverter.
 - g. Overcurrent protection, disconnect, and rapid shutdown devices.
 - h. Mounting structure.
 - i. Meter.
- C. Stand-Alone PV System: Collectors connected to provide power to Project dc and ac loads through an energy storage system.
 - 1. System Components:
 - a. PV modules.
 - b. Array frame.

- c. Charge controller.
- d. Energy storage.
- e. Inverter.
- f. Overcurrent protection, disconnect, and rapid shutdown devices.
- g. Mounting structure.

2.02 MANUFACTURED UNITS

- A. Cell Materials: Copper indium gallium (di)selenide (CIGS).
- B. Cell Materials: Cadmium telluride (CdTe).
- C. Front Panel: Tempered glass.
- D. Backing Material: Tempered glass.
- E. Junction Box:
 - 1. IP Code: IP65.
- F. Charge controller.
- G. Inverter Control Type: Pulse-width-modulation control.
- H. Disconnects: Rated for system voltage and conductor.
- I. System Overcurrent Protection: Fuses.

2.03 FRAMING

- A. Entire assembly listed for Class A fire rating according to UL 1703.
- B. Finish: Anodized aluminum.

2.04 INVERTER

- A. Central or micro inverters as required for the project requirements .
- B. Galvanized steel, NEMA 250, Type 3R enclosure.

2.05 MOUNTING

- A. Roof Mount: Extruded aluminum.
- B. Pole mount.
- C. Tracking Mounts: Two axis.

END OF SECTION

SECTION 26 32 13

EMERGENCY MOTOR GENERATOR

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged engine generator system
- B. Exhaust silencer and fittings
- C. Fuel fittings and day tank
- D. Remote annunciator panel
- E. Battery and charger
- F. Weatherproof enclosure

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Kohler.
- B. Generac
- C. Onan
- D. Campus Standards
 - 1. East LA College and Southgate Environmental Center – Onan, Caterpillar, Kohler
 - 2. LA Harbor College – Onan, Caterpillar, Kohler, Cummins
 - 3. LA Mission College – Caterpillar
 - 4. LA Pierce College – Onan, Caterpillar
 - 5. LA Southwest College – Kohler
 - 6. LA Trade Tech College – Caterpillar
 - 7. LA Valley College – Onan, Caterpillar
 - 8. West LA College – Onan, Kohler, Caterpillar

2.02 PACKAGED ENGINE-GENERATOR SET

- A. Packaged engine-generator set shall be a coordinated assembly of compatible components.
- B. Safety Standard: Comply with ASME B15.1 and UL 2200.

- C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.
- D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.
- E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

2.03 ENGINE

- A. Type: Water-cooled in-line or V-type, four-stroke cycle spark-ignition compression ignition diesel electric ignition internal combustion engine.
- B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.
- C. Fuel: Appropriate for use of No. 2 fuel oil.
- D. Engine Speed: 1800 RPM.
- E. Governor: Isochronous type with speed sensing.
- F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine over crank. Limits as selected by manufacturer.
- G. Frequency Response:
 - 1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 - 2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.
- H. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve. Fuel Supply System: Comply with UL 142 fuel oil tank.
 - 1. Day Tank: UL listed fuel tank with 4 hour rated capacity. Integral rupture basin with 150% of nominal capacity and leak detection. Dual integral self-priming pumps and level control with indication. Low-level sensor at 25% with alarm and contacts. High-level sensor with alarm, contacts, and redundant fuel shutoff. Include flexible fuel line connections for all supply and return lines as indicated on the Mechanical Plumbing drawings. Provide with emergency vent cap.
 - a. Approved Manufacturers: Simplex, Tramont, Pyrco.

2. Base-Mounted Fuel Tank: UL 2080 listed fuel tank with 8 hour rated (NFPA 110 minimum run time by class) capacity. Integral rupture basin with leak detection. Provide fueling port with an overflow prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors lockable cover, and analog level gauge. Furnish complete with float switches to indicate low fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.
- I. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.
- J. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 120 volts AC. The minimum wattage of the heater shall be watts or as recommended by the manufacturer.
- K. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump.
 1. Remote Radiator: Vertical air discharge. Multiple belt drive from totally enclosed sealed bearing motor. Sized by generator manufacturer.
 2. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.
 3. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.
 4. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.
- L. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:
 1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.
 2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.
 3. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
- M. Exhaust System: Critical type silencer (85 dBA max at 10 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of 3/4" drain line. Opening shall be flush on inside of silencer.
- N. The packaged engine generator shall comply with the current Environmental Protection Agency EPA Emissions standards.

- O. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.
- P. Mounting: Provide unit with suitable spring-type vibration isolators.

2.04 GENERATOR

- A. Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.
- B. Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.
- C. Insulation: ANSI/NEMA MG 1, Class H.
- D. Temperature Rise: 105°C continuous.
- E. Enclosure: ANSI/NEMA MG 1; open drip-proof.
- F. Voltage Regulation:
 - 1. The maximum instantaneous voltage dip (IVD) shall be 30 percent for building loads and 15 percent for the fire pump.
 - 2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation ± 1 percent from no load to full load. Include manual controls to adjust voltage drop ± 5 percent voltage level, and voltage gain.
- G. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.05 CONTROLS AND INDICATION

- A. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- B. Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.
 - 1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.
- C. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
 - 1. Alarm indication as required by NFPA 110 for a Level 1 system.
 - 2. AC frequency meter.
 - 3. AC output voltmeter with phase selector switch.
 - 4. AC output ammeter with phase selector switch.

5. Output voltage adjustment.
 6. DC voltmeter (alternator battery charging).
 7. Engine start/stop selector switch.
 8. Engine running time meter.
 9. Oil pressure gauge.
 10. Engine coolant temperature gauge.
 11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
 12. Fuel derangement alarm.
 13. Generator overload.
 14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
 15. Remote Alarm Contacts: Pre-wire SPST contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
 16. Ground fault indication.
- D. Remote Engine Annunciator Panel: ANSI/NFPA 99 and NFPA 110 for a Level 1 2 system. Include the listed pre-alarm and alarm points, audible alarm, alarm silencing means, repetitive alarm circuitry, and lamp test switch in a surface mounted panel with brushed OR color painted finish. Provide all interconnecting wiring in conduit per manufacturer's requirements by the Electrical Contractor. The remotely reported alarms shall include the following.
1. Overcrank
 2. Low water (engine) temperature
 3. High engine temperature pre-alarm
 4. High engine temperature
 5. Low lube oil pressure pre-alarm
 6. Low lube oil pressure
 7. Overspeed
 8. Low fuel main tank
 9. Low coolant level
 10. Not in auto
 11. Emergency Power Supply (EPS) supplying load
 12. High battery voltage
 13. Low battery voltage
 14. Battery charger failure (includes AC failure)
 15. Generator running
 16. Normal utility power
 17. Emergency stop
 18. Emergency Power Off Switch activated (EPO)
 19. Alarm for power supply or UPS serving motorized breakers

E. Building Automation System Integration:

1. Provide a terminal block to allow the Facility Monitoring and Control System (FMCS) to report generator alarms. Provide individual terminal points for each of the annunciator alarms and pre-alarms. Provide an additional terminal point to combine all generator alarms under a single terminal point. Provide a permanent label for each terminal point. Each terminal will provide a binary output for the FMCS to read. Refer to Specification Section 23 09 00 for alarms reported by the FMCS.

F. Diesel Particulate Filter

1. Provide diesel particulate filter for generators that are located within 100 meters from K-12 schools.

2.06 ACCESSORIES

A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic electronic trip type; 100% rated breaker complying with NEMA AB1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.
4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
5. Arc Energy Reduction: Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy system shall be provided for overcurrent protection devices rated 1200 amps or larger.

B. Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.

C. Remote Fuel Fill Station: Provide a remote fuel fill station including a fill port within a surface-mounted, lockable, NEMA 3R stainless steel construction with gasketed hinged door and lockable handle. The fill port shall have a minimum overflow holding capacity of five (5) gallons. The fill port inside the cabinet shall be field coordinated. Provide dust cover for fill connection. Include local light and horn alarm with test switch and silence feature when tank level is above 95 percent full. Provide additional float switch in tank for level indication. Include the following accessories:

1. Solenoid valve to prevent additional fuel delivery to the tank when full; 120-volt power provided by Contractor.
2. Lockable drain valve for overflow.
3. Local analog gauge of main tank fuel level.
4. Local digital gauge of main tank fuel level.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE SKIN-TIGHT

A. Prefabricated or pre-engineered skintight enclosure with the following features:

1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components, including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.
2. The generator control panel shall be located no greater than 5'-0" above finished grade for ease of access.
3. Structural Design and Anchorage: Wind resistant up to 100 mph.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays.
5. Hinged Doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.
6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.
7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5'-0" above finished grade.
9. The exhaust system silencer shall be installed within the enclosure housing.

2.08 SITE COORDINATION

- A. Generator to property line distance: 10 feet minimum.

END OF SECTION

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SECTION 26 33 23

CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Central battery equipment for emergency lighting.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Myers Power
- B. DSPM Lighting Inverters
- C. Crucial Power Products (CPP)
- D. Campus Standards
 - 1. LA Mission College – Myers Power
 - 2. LA Pierce College – Myers Power
 - 3. LA Valley College – Myers Power
 - 4. West LA College – Myers Power

2.02 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

- A. Performance Requirements: Passive standby (off-line) system.
- B. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent.
 - 2. Input Frequency Tolerance: Plus or minus 3 percent.
 - 3. Synchronizing Slew Rate: 1 Hz per second, maximum.
 - 4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.
 - 6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F (20 deg C) and not exceeding 86 deg F (30 deg C).
 - 7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C).
 - 8. Ambient Temperature Rating (Batteries): Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).

9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C).
 10. Humidity Rating: Less than 95 percent (noncondensing).
 11. Altitude Rating: Not exceeding 3300 feet (1005 m).
 12. Off-Line Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
- C. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.
- D. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker.
1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22 kA This shall be higher as required by the project's Electrical Distribution Study.
- E. Inverter: Solid-state, high-frequency, PWM type.
- F. Rectifier/Battery Charger: Solid state, variable rate, temperature compensated.
1. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
- G. Batteries: Premium VRLA batteries.
1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
- H. Maintenance Bypass Systems: Internal; manual operation only.
1. Transfer and Retransfer: Break-before-make, with disrupting power to the load.
- I. Integral Output Disconnecting Means and OCPD:
1. Single-Output OCPD: As scheduled Thermal-magnetic circuit breaker, complying with UL 489.

2.03 COMPONENTS AND ACCESSORIES

- A. Enclosures: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- B. Output breaker to match unit's output with option for branch distribution breakers. Coordination to be provided for upstream breakers as required on emergency systems.
- C. SPD Device
- D. Multiple-output voltages.
- E. Split-output configuration.
- F. Internal fax modem.
- G. Audible alarm with silencer switch.
- H. Remote summary alarm panel.
- I. Remote meter panel.

END OF SECTION

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SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Static uninterruptible power supply.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - STATIC UNINTERRUPTIBLE POWER SUPPLY

- A. Liebert, Emerson Network Power
- B. Eaton Corporation
- C. Schneider Electric
- D. General Electrical (GE Critical Power)
- E. Mitsubishi Electric Power Products, Inc.
- F. Active Power
- G. MGE UPS Systems
- H. APC UPS Systems
- I. Myers Power Systems

2.02 CAMPUS STANDARDS

- A. East LA College and Southgate Environmental Center – APC, MGE, Schneider Electric
- B. LA Harbor College – Shneider Electric, Eaton, Myers Power Systems
- C. LA Mission College – APC
- D. LA Pierce College – Liebert, APC, Schneider Electric
- E. LA Southwest College – APC, Eaton
- F. LA Trade Tech College – Liebert, APC
- G. LA Valley College – APC, Eaton
- H. West LA College – Liebert, APC, Eaton

2.03 SYSTEM RATINGS AND OPERATING CHARACTERISTICS

- A. System Continuous Rating: As shown on the drawings, over entire battery voltage range at specified power factor. Maintain output voltage within specified limits at any load from full load to no-load.
- B. Battery Capacity: Capable of operating at full load for 30 minutes or higher as required per project program, school standards, etc.
- C. Voltage Rating: 480Y/277 volts, 3 phase input; 480Y/277 volts, 3 phase output.
- D. Input Voltage Limits: +10 percent/-15 percent without battery discharge.
- E. Input Frequency: 60 \pm 6 Hertz.
- F. Input Current Limit: Adjustable to maximum of 120 percent of that required to operate at full load with battery bank on float charge.
- G. Current Walk-In: 25 to 100 percent in 30 seconds (programmable).
- H. UPS Power Factor Over Full Range of Loads and Input Voltages: 0.99 lagging.
- I. Harmonic Distortion of Input Current Wave Form: 5 percent maximum at full load.
- J. Output Voltage Regulation:
 - 1. \pm 0.5 percent for balanced load, full range of DC input and no load to full load variations.
 - 2. \pm 2 percent for 50 percent unbalanced load, full range of DC input and no load to full load variations.
 - 3. \pm 5 percent during maximum overload of the system.
- K. Output Voltage Adjustment: \pm 5 percent.
- L. Output Free Running Frequency: 60 Hertz \pm 0.1 percent.
- M. Frequency Adjustment: \pm 2 Hertz.
- N. Output Harmonic Distortion: Maximum 5 percent rms total harmonic distortion (THD) and maximum 3 percent any single harmonic, at rated frequency and voltage, from 10 percent load to full load and over battery voltage range, measured into a linear load.
- O. Voltage Transient Response for Application of 0 to 50 Percent, 50 to 100 Percent, 100 to 50 Percent, and 50 to 0 Percent Step Loads, and Transfer to and From Bypass Line:
 - 1. +8, -10 percent for a maximum of 8.3 milliseconds.
 - 2. \pm 5 percent for a maximum of 25 milliseconds.
 - 3. \pm 3 percent for a maximum of 50 milliseconds.
 - 4. Recovery to steady state within 100 milliseconds after any out-of-tolerance variation.
- P. Phase Displacement:
 - 1. 120 \pm 1 degree for balanced loads.
 - 2. 120 \pm 4 degrees for 50 percent unbalanced loads.
- Q. Three-phase Overload Ratings:

1. 1000 percent for 10 ms; via static switch.
 2. 110 percent continuous.
- R. Output Current Limit: 110 percent of rated output current.
- S. Voltage Unbalance: 3 percent maximum line-line with 100 percent load unbalance.
- T. Efficiency: 96 percent at full load. 96.5 percent @ 50% load.
- U. Surge Protection: IEEE 587, Class A & B.

2.04 PHYSICAL CHARACTERISTICS

- A. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service, except as required during factory testing. All active electronic devices shall be solid-state. All power semi-conductors shall be hermetically sealed. All relays and semi-conductors shall be dust-tight.
- B. Wiring: Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA, and applicable local codes and standards. All bolted connections of bus bars, lugs, and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked.
- C. All power, control, and printed circuit components shall be mounted in bolt-on and/or swing-out type assemblies for ease of maintenance and replacement. Replacement of components shall not require the use of a soldering iron.
- D. Construction and Mounting: The UPS shall be NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling. Wire runs shall be protected in a manner which separate power and control wiring. Provisions shall be protected in a manner which separate power and control wiring. Provisions shall be made in the cabinets to permit installation of input, output, and external control cabling, using raceway or conduit.
- E. Ventilation: Adequate ventilation shall be provided to ensure that all components are operated within environmental ratings. Cooling fans shall be redundant. All fans are to be equipped with fan failure sensors connected to an alarm on the UPS control panel.
- F. Temperature sensors shall be provided to monitor UPS internal temperature. Upon detection of temperatures in excess of manufacturer's recommendations, the sensors shall cause audible and visual alarms to be sounded on the UPS control panel. A separate room ambient temperature sensor shall be provided to give an alarm if the temperature of the inlet air to the UPS is above specified limits.

2.05 RECTIFIER/CHARGER

- A. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert AC to regulated DC for input to the inverter and for charging the battery.
- B. Input Circuit Breaker: Internally mounted circuit breaker shall be of the frame size and trip rating to supply full rated load and recharge the battery at the same time. The circuit breaker shall have a shunt trip device operated by internal UPS control equipment.

- C. Transformer: A dry power transformer of the isolated winding type with vacuum impregnated windings shall be used. It shall be all copper wiring and have one 5% tap below and one 5% tap above rated voltage. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating full load at maximum ambient temperature.
- D. Battery Charge Current Limiting: The rectifier/charger shall be equipped with a battery charge current limit circuit that shall limit battery charging to an adjustable level of 2% to 25% of full rectifier input current. The circuit shall have a second adjustment to provide greater limiting when signaled by the emergency generator. This circuit shall allow input power limiting but shall not cause battery discharge when a low AC input voltage condition occurs. Battery charge current limit is to be set at 15% for normal operation and 2% for "generator" operation. Electrical Contractor shall make required connections to generator.
- E. Input Current Walk-In: The rectifier/charger shall provide feature which upon AC power return to the AC input bus, after the UPS has been operating on battery power or has been de-energized, limits the total initial power requirement at the input terminals to 20% of rated load, and gradually increases power to 100% of full rating over the 15-second time interval.
- F. Fuse Failure Protection: Semi-conductors in the rectifier/charger shall be fused with fast-acting fuses so that loss of any semi-conductor shall not cause cascading failures. All fuses shall have a blown fuse indicator with an alarm light on the control panel.
- G. Output Filter: The rectifier/charger shall have an output filter to minimize ripple current into the battery. Under no conditions shall ripple current into the battery exceed 2% RMS. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier with the battery disconnected.
- H. Battery Recharge: In addition to supplying power for the load, the rectifier/charger shall be capable of recharging the battery as specified herein. The charging rate shall be sufficient to restore the battery from discharge to 95% charge within ten (10) times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.
- I. Battery Equalize Charge: An automatic equalize charge timer feature shall be provided to automatically apply an equalize voltage to the battery after a 5 second or longer utility outage. The duration of equalize charge time shall be adjustable from 0-72 hours. Manual override shall be provided for the automatic equalize circuit.
- J. Over-voltage Protection: There shall be DC over-voltage protection so that if the DC voltage raises to the pre-set limit, the UPS is to shut down automatically and the load transferred to the bypass line uninterrupted.

2.06 INVERTER

- A. The term inverter shall denote the equipment and controls to convert DC from the rectifier/charger or battery to precise AC to power the load. The inverter shall be solid-state, capable of accepting the rectifier/charger or battery output and providing rated output. The inverter is to be power SCR type, six (6) twelve (12) pole design. power transistor type, phase controlled pulse width modulated (PWM) design.

- B. **Overload Capability:** The inverter shall be able to sustain an overload across its output terminals up to 150% for 30 seconds without reducing output voltage. The inverter shall be capable of at least 300% current for short circuit conditions. If the short circuit is sustained, the inverter shall shut down and disconnect automatically from the critical load bus.
- C. **Output Frequency:** Output frequency of the inverter shall track the static bypass source provided source frequency maintains 60 Hz \pm 0.5 Hz to maintain synchronous operation for automatic transfers. If the bypass source fails to maintain proper frequency then control shall revert to an internal oscillator. The oscillator shall be temperature compensated and hold the inverter output frequency to \pm 0.1% for steady-state and transient conditions. Drift shall not exceed 0.1% during a 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.
- D. **Phase Balance:** Electronic controls must be used to provide individual phase voltage compensation to obtain phase balance under all conditions including up to 50% load unbalance.
- E. **Internal Protection:** Fault sensing and static isolation shall be part of the inverter as well as an output circuit breaker for removal of a faulted module from the load, without affecting the critical load but beyond the stated limits.
- F. **Fuse Failure Protection:** Semi-conductors in the inverter shall be fused with fast acting fuses to prevent cascading failures. Each fuse shall be provided with blown fuse indicator with an alarm light on the control panel.
- G. **Output Circuit Breaker:** Internally mounted circuit breaker shall be of the frame size and trip rating to supply full rated load. The circuit breaker shall have a shunt trip device operated by internal UPS control equipment.
- H. **Load Sharing:** The inverter shall be capable of load sharing operation with like UPS modules without the use of master controls, oscillators, or sharing reactors. The inverters shall load share to within \pm 5% of the average individual inverter load current.
- I. **Output Power Transformer:** A dry power transformer of the isolated winding type with vacuum impregnated windings shall be used. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.
- J. **Output Filter:** The inverter shall have an output filter to maintain the total harmonic distortion (THD) of the output voltage to the specified limits.

2.07 SYSTEM PROTECTION

- A. **Built-in Protection:** Against surges, sags, and over-current from the AC source, over-voltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system.
- B. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions.

- C. Fast-acting current limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. Open protective devices shall be indicated by Light Emitting Diodes (LEDS) on the control panel.

2.08 DISPLAY AND CONTROLS

- A. The term UPS Module Control Panel, as used herein, denotes that portion of the UPS module containing the display screen and control functions. The display panel shall be liquid crystal type to provide complete monitoring and control using menu-prompted commands. Switches shall be used to select and execute operations from a Master Menu. The display and control panel shall be mounted on the control section door.
- B. UPS module system logic and control programming shall be resident in Application Specific Integrated Circuits. Logic components shall be physically isolated from heat sources and voltage hazards. There shall be two power supplies for the logic and control circuits, one connected to the input AC source and the other connected to UPS module output.
- C. Monitoring: UPS module monitoring shall be provided by a microprocessor-based graphic display capable of simultaneously reporting input and output and battery voltage and current; output frequency and total load KVA and KW for all three phases, within 1% accuracy.
 - 1. History File: The control system shall maintain this information in discrete windows updating memory on a First-In First-Out basis. This shall provide status recall of a period of at least 256 milliseconds (64 windows); 160 milliseconds before the malfunction (40 windows), and 96 milliseconds after the malfunction (24 windows).
 - 2. Power Flow Indication: Power flow indicators shall graphically depict whether the load is being supplied from UPS, bypass or battery and provide, on the same screen, input, output and battery voltage, amperages, frequency, KVA and KW. The following components must be indicated:
 - a. AC Input Circuit Breaker
 - b. Battery Circuit Breaker
 - c. Inverter Output Circuit Breaker
 - d. Bypass Switch
 - e. Static Transfer Switch (Off-Line/Available)
 - 3. Battery Status Indicator: The battery status indicator shall display DC alarm and shutdown voltages and maintain the battery voltage drop during discharge. Battery time remaining after a power outage shall be graphically displayed to permit prediction of battery shutdown.
- D. Alarms: The control panel shall report the system level alarms listed below. An audible alarm is to be activated when any of the above alarms occur. All alarms shall be displayed in text form.
 - 1. Input Power Fail
 - 2. Output Overload
 - 3. Overload Shutdown
 - 4. Overload Transfer
 - 5. Emergency Power Off

6. DC Over Voltage
 7. DC Cap Fuse
 8. Ambient Over-temp
 9. UPS Over-temp
 10. Over-temp Shutdown
 11. Low Battery Reserve
 12. Battery Disconnected
 13. Battery Discharging
 14. Rectifier Fuse Failure
 15. Inverter Fuse Failure
 16. Fan Failure
 17. Static Switch Disabled
 18. Bypass Not Available
 19. Auto Transfer to Bypass
 20. Reverse Power
 21. Control Power Failure
 22. Load on Bypass
 23. Output Over/Under Voltage
- E. Controls: System level control functions shall be:
1. UPS/Bypass Transfer Pushbuttons.
 2. AC Output Voltage Adjust 5%.
 3. Battery Circuit Breaker Trip Pushbutton.
 4. Emergency Power Off Pushbutton with Protective Cover.
 5. Alarm Silence Pushbutton.
 6. Control Enable Pushbutton.
 7. Display Control Switches.
 8. Alarm Reset Switch.
- F. Manual Procedures: Start-up, load transfers, and shutdown procedures shall be detailed on the display panel in text and graphic form.
1. Start-Up:
 - a. Step-by-step procedure screen.
 - b. Walk-in display screen to simultaneously indicated DC volts, output volts, and input phase amps.
 - c. Mimic screen to indicate power flow.
 2. Load Transfers:
 - a. Step-by-step procedure screen.
 - b. Mimic screen to indicate power flow.

3. Shutdown:
 - a. Step-by-step procedure screen.
 - b. Mimic screen to indicate power flow.

- G. Emergency Power Off: The UPS control panel shall have a local emergency shutdown. Pressing the emergency shutdown shall cause:
 1. Uninterrupted transfer of the load to bypass.
 2. The input, output, and battery breakers.
 3. Power off circuit, which completely removes power from the critical bus when activated.

- H. Self-Diagnostics: The UPS module shall be provided with the following built-in diagnostics for troubleshooting and circuit alignment aids:
 1. Rectifier in control mode.
 2. UPS synchronizing with critical load bus.
 3. Positive DC bus ground fault.
 4. Negative DC bus ground fault.
 5. Bypass frequency higher than system output frequency.
 6. Bypass frequency lower than system output frequency.
 7. Automatic static transfer lockout.
 8. Command given to close inverter output circuit breaker.
 9. Command given to close bypass switch.
 10. Command given to open inverter output circuit breaker/bypass switch.
 11. Degree of overload.
 12. Under-voltage trip for battery disconnect switch.
 13. Under-voltage trip for input circuit breaker.

- I. Remote Monitoring Capability: UPS control circuits shall be interfaced with the site central monitoring system (CMS). Interface shall be built into the UPS. The site monitoring signal processing module shall be factory installed. The following shall be available for display:
 1. Metering:
 - a. Bypass volts (line-line, all phases)
 - b. Critical bus volts (line-line & line-neutral, all phases)
 - c. Critical bus current (all phases)
 - d. Critical bus frequency
 - e. Critical bus KVA
 - f. Critical bus KW
 - g. DC volts
 - h. Battery amps (\pm)
 - i. % Capacity
 2. Digital Alarms:

- a. Fuse Cleared
 - b. Output Overload
 - c. Emergency Power Off
 - d. Ambient Over-temp
 - e. Battery Flywheel Discharging
 - f. Low Battery Reserve
 - g. Load On Bypass
 - h. Static Switch Disabled
 - i. Battery Flywheel Disconnected
 - j. Module Cooling Failure (Fan Failure or Over-temp)
 - k. Control Power Failure
3. Alarm Outputs: The following will have a N.O. isolated contact for remote indication on the RTU provided by others. Electrical Contractor shall route conduit and wire, make all connections.
- a. UPS System Mode
 - b. Battery Flywheel Discharging
 - c. Low Battery Reserve
 - d. UPS Alarm Condition
- J. Communication Port: The UPS shall be provided with an RS-232 port capable of interfacing with a remote location. All monitoring information shall be capable of being downloaded to remote device.

2.09 STATIC TRANSFER SWITCH

- A. The term static transfer switch shall denote the solid-state device that automatically transfers the critical load to bypass without interruption if the UPS cannot supply continuous power. The term bypass switch shall denote the electromechanical device that will connect the load to bypass. Automatic load transfers are to be initiated when a malfunction occurs within the UPS or a sustained system overload occurs.
- B. Momentary Overloads: In the event of a branch load circuit fault or load current inrush, the static transfer switch is to pulse-on for at least 40 milliseconds allowing at least 1000% load current to flow from bypass line to clear the overload. If the overload is cleared, a load transfer shall not be made. If the overload is not cleared, then the transfer is to be accomplished maintaining load voltage within specified limits.
- C. Automatic Closing: The static transfer switch is to be of the energy saving type. Once the load is transferred to the bypass line by the static transfer switch, the bypass switch is to automatically close removing the static transfer switch from the power flow.
- D. Manual Transfers: A manual load transfer between the UPS and bypass line is to be initiated from the control panel. All transfers from bypass to the inverter shall be manually initiated.
- E. Switch Isolation: The static switch SCR device shall include series connected switch/circuit breaker and backfeed circuit monitoring per UL Standard 1778 for automatic (and manually) initiated circuit isolation of static switch SCR device.

2.10 BATTERY DISCONNECT BREAKER

- A. The UPS shall have a properly rated circuit breaker (500 VDC) to isolate it from the battery.
- B. The switch shall be in the battery compartment of the UPS module housing. When open, there shall be no battery voltage in the rectifier/inverter compartment.
- C. The UPS shall automatically be disconnected from the battery by opening the switch when the battery reaches the minimum discharge voltage level or when signaled by other control functions.
- D. The UPS shall be provided with a pushbutton to trip the breaker from the control panel.

2.11 BATTERY

- A. Storage Battery: Valve regulated (sealed, reduced maintenance) type. Maximum specific gravity of 1.3, and minimum cell end voltage of 1.65 volts. Heavy duty industrial design. Provide with impact resistant plastic case which meets or exceeds 94V2 to meet UL Standard 1778 requirements.
- B. Batteries shall be furnished with flame arrestors, lead covered solid copper terminal posts, and transparent container to allow visual inspection of the plates and sediment spaces.
- C. Battery system shall be furnished as a part of the UPS system and sized to maintain the rated UPS system load output for the specified duration. Submit battery Amp-hour rating, cell end voltage, specific gravity, and battery system calculations with shop drawing submittals.
- D. Battery system design life shall be 10 years under full float operation and shall be provided with a pro rata cycle duty warranty based on the following discharges at the 15-minute rate:

CYCLE DURATION

NUMBER OF CYCLES	0 to 30s	30s to 1M	1M to 5M	5M to 15M
	3,700	1,125	410	225
	2,700	600	200	120
	10,500	2,100	660	300
	4,571	2,560	853	481

- E. The battery system shall provide 100% of specified capacity at initial start-up.
- F. Batteries shall be mounted on slide out racks in battery compartment of UPS module enclosure.
- G. Rack system shall be painted with corrosion resistant paint and supplied with all required lead plated copper bolted connectors, terminal lugs, cable supports, rack mounting bolts, and accessories. Provide acid resistant aisle matting adjacent to racks.
- H. Racks shall be sized to fit into battery room as shown on the drawings and configured to hold batteries totaling 250 VDC maximum. Contractor shall size conductors and conduit between UPS and battery disconnect breaker, and between battery disconnect breaker and battery racks as required by UPS supplier. All cables leaving a continuous rack area shall be in conduit.
- I. Provide the following battery system accessories:
 1. Set of battery identification numbers.
 2. Battery arrangement and wiring diagram indicating battery numbers.

3. Lifting strap and spreader block.
4. Anti-corrosion compound.

2.12 EMERGENCY POWER OFF

- A. The UPS shall include an Emergency Power Off (EPO) circuit. Activating this circuit shall cause immediate shutdown of all UPS operations. This operation will shut down the critical load.
- B. The UPS module shall include provisions to activate the EPO circuit remotely by a contact closure.

END OF SECTION

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SECTION 26 36 00
TRANSFER SWITCH

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Automatic transfer switch
- B. Manual transfer switch
- C. Remote annunciator for ATS

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ASCO.

2.02 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 2; automatic transfer switch.
- B. Configuration: Electrically-operated, mechanically-held transfer switch.
- C. Control panel shall be micro-processor based.

2.03 AUTOMATIC TRANSFER

- A. Description: NEMA ICS 2; automatic transfer switch
- B. Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, and DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch.

2.04 MANUAL TRANSFER SWITCH

- A. Description: NEMA ICS2; manual transfer switch.
- B. Configuration: Manually operated, three-position center-off transfer switch.
- C. Engine start switch.

2.05 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 1.

2.06 RATINGS

- A. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two AIC values when the AIC rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.
- B. Series rating with upstream devices shall be allowed per UL-1008.

2.07 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
- G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

2.08 ENCLOSURE

- A. Enclosure: NEMA ICS 6; Type 1.

2.09 ACCESSORIES

- A. Load Shed:
 - 1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under- frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.
 - 2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.
 - 3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.
- B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.
- C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.
- D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.
- E. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

- F. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.
- G. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.
- H. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.
- I. Engine Exerciser: Start engine every 28 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.
- J. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.
- K. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:
 - 1. Normal source available.
 - 2. Emergency source available.
 - 3. Exercise mode in operation.
- L. Serial Communication Port: Two twisted pairs of shielded communication cable in conduit shall daisy chain all transfer switches with a remote annunciator.
- M. Remote Annunciator: A remote annunciator shall be provided that shall monitor and control the following functions for each transfer switch:
 - 1. Load Connect to Emergency/Normal Indication
 - 2. Source Available: Emergency/Normal Indication
 - 3. Time Delay Indication and Key Locked Bypass Switch
 - 4. Transfer Test Indication and Key Locked Switch
 - 5. Remote transfer loads between normal and emergency sources with Key Locked Switch
 - 6. Remote generator start with Key Locked Switch
 - 7. Remote generator stop with Key Locked Switch
- N. Annunciators shall be located as directed by the Owner. Extend conduit and wire as required by the manufacturer.
- O. An adjustable emergency to normal pre-signal signal to elevator controller.
- P. Metering Capabilities: The following metered readings shall be available at the local display. [The metering information shall also be shared by serial connection to the master control cubicle of the emergency power paralleling equipment.]
 - 1. Current, per phase RMS and neutral
 - 2. Current unbalance %
 - 3. Voltage, phase-to-phase and phase-to-neutral
 - 4. Voltage unbalance %
 - 5. Real power (KW), per phase and 3-phase total

6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated energy, (KWH, KVAH, and KVARH)
11. Demand, (KWH, KVA)

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires, drivers, and accessories
- B. Performance Requirements
- C. Luminaire Requirements

1.02 DEFINITIONS

- A. CCT: Correlated color temperature, measured in degrees Kelvin (K)
- B. CRI: Color rendering index
- C. IES: Illuminating Engineering Society

PART 2 PRODUCTS

2.01 INTERIOR LIGHT FIXTURES (LED)

- A. Acceptable manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer can furnish the complete system as specified herein.
 - 1. Prudential, Lithonia, Lightolier, and HE-Williams
 - 2. Campus Standards
 - a. East LA College & South Gate Educational Center – Prudential, Lithonia, HE Williams, Lightolier Smart System preferably in the IoT Platform
 - b. LA Harbor College – Prudential, Lithonia, HE Williams, Lightolier, Meets Energy Star Requirements
 - c. LA Mission College – LED
 - d. LA Pierce College – Lithonia, Cree
 - e. LA Southwest College – Prudential, Lithonia, HE Williams, Lightolier, must meet DLC, Energy Star requirements.
 - f. LA Trade Tech College – LED by GE, Lithonia, Hubbell
 - g. LA Valley College – Prudential, Lithonia, HE Williams, Lightolier
 - h. West LA College – Prudential, Lithonia, HE Williams

2.02 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish, and install listed enclosures around luminaires that maintain the system rating.
- B. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction. Provide ballast covers to separate inboard/outboard lamps when multi-level switching is indicated, so light does not spill into unlit cells.
- C. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified.
1. Acceptable Manufacturers
 - a. Prudential
 - b. Lithonia
 - c. Campus Standards
 - 1) East LA College and Southgate Environmental Center – Prudential, Lithonia, Philips
 - 2) LA Harbor College – Prudential, Philips, LED with 10 years warranty on LED and driver
 - 3) LA Mission College – Lithonia, LED
 - 4) LA Valley College – Designer to submit for LAVC approval
 - 5) West LA College – LED type, 10 years warranty on LED and driver.
- D. Exit Signs: Stencil single or double face, 6-inch high letters with green color, with or without directional arrows, universal mounting type as indicated on the drawings.
1. Acceptable Manufacturers - Campus Standards
 - a. East LA College & South Gate Educational Center – LED, Active Safety, Pentico, Lithonia, Extronix
 - b. LA Harbor College, LA Mission College, LA Pierce College, West LA College – LED
 - c. LA Southwest College – LED, Active Safety, Pentico, or equal
 - d. LA Trade Tech College – LED, Active Safety, Spectron or equal
 - e. LA Valley College – LED by Active Safety, Spectron
- E. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- F. Painted reflector surfaces shall have a minimum reflectance of 90%.
- G. Restroom Light Fixtures – Campus Standards

1. LA Harbor College – vandal-resistant construction preferred.
2. LA Trade Tech College – vandal-resistant construction preferred.

H. Vandal Proof Lighting Fixtures

1. LED by Ruud Lighting/Cree, Metalux, Kim Lighting
2. Campus Standards
 - a. East LA College and Southgate Environmental Center – Rude, Stanco, Sequoia, BE, Lucalux, Metalux. Smart system, preferably in the IoT platform. The controls shall have to communicate and work with HVC controls through BACnet.
 - b. LA Harbor College – LED with 10 years warranty on LED and driver, Ruud/Cree, Stanco
 - c. LA Mission College – LED type, 10 years warranty on LED and driver.
 - d. Southwest LA College – Ruud Lighting, Stanco, Sequoia, BE, Lucalux, Metalux
 - e. LA Trade Tech College – LED by Eaton, Lamar, Luminaire
 - f. LA Valley College – LED by Ruud, Stanco, GE
 - g. West LA College – LED type, 10 years, warranty on LED and driver

2.03 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Color temperature of the luminaires shall be 3500 Kelvin (in accordance with the specific requirements for a given space).
- B. LED luminaires shall have a minimum efficacy of 100 lumens per watt.
- C. LED chip arrays specified as color changing shall have chip colors.
- D. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- E. Luminaire minimum lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.
- F. LED luminaires shall have a total harmonic distortion (THD) of 20% or lower.
- G. LED luminaires shall have a power factor of 0.9 or above.
- H. LED Driver:
 1. Solid state driver with integral heat sink. Driver shall have over heat, short-circuit, and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20%. Surge suppression device for all exterior luminaires.
 2. Drivers shall have dimming capabilities.
 3. Driver shall have a minimum of 50,000 hours rated life.
- I. Luminaires shall conform to Title 24 lighting and lighting control standards.
- J. LED luminaire shall have a minimum warranty of 5 years if available.

2.04 SUBSTITUTIONS

- A. Prior approval is a procedure for substitution of products before issuance of bid documents. These substitutions may be requested by the bidder, contractor, subcontractor, manufacturer, or other qualified party who wishes to propose use of an alternate product in lieu of that specified.
1. The prior approval request shall include sufficient data so that direct comparison of a proposed product to a specified product can be made.
 2. If a prior approval request is received (before issuance of bid documents), the request will be reviewed at the specifier's discretion. Inadequate warranty, vagueness of submittal, failure to meet project requirements, or insufficient data may be cause for disapproval or rejection of request.
 3. Upon review, the Luminaire Schedule will be updated to reflect the accepted alternates.
- B. Any alternate product not listed on the Luminaire Schedule as shown in the Drawings at the issuance of bid documents shall be formally submitted to the design team as a substitution request. Refer to other Sections of these Specifications for substitution requirements.

2.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
 4. Structural members to which **equipment and** luminaires will be attached.
 5. Access panels.
 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample warranty.

2.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
 - 2. Provide driver and light engine replacement installation instructions as applicable.

2.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Screw-in Lamps for Decorative Luminaires: **Ten for every 100** of each type and rating installed. Furnish at least two of each type.
 - 2. Luminaires with LED light engines: **Ten for every 100** of each type and rating installed. Furnish at least two of each type.
 - a. Does not apply to decorative luminaires.

2.08 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 - 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All light fixtures shall be in area of easy access for maintenance. No overhead light fixtures over the raised floor if possible.
- B. All selected light fixtures shall have minimum effort in luminaire repair/replacement.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

3.03 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: **Five** year(s) from date of Substantial Completion.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lighting and security walkway lighting
- B. LED's
- C. Drivers
- D. Poles

PART 2 PRODUCTS

2.01 LANDSCAPING FIXTURES

- A. West LA College Campus Standards:
 - 1. Cree
 - 2. Deco
 - 3. Cooper

2.02 EXTERIOR LIGHTS - PARKING LOT FIXTURES

- A. Kim Lighting LED, Hubbell MH
- B. Campus Standards
 - 1. East LA College and South Gate Educational Center – LED (Lamp wattage to match existing)
 - 2. LA Mission College – LED Type, 10years warranty on LED and Driver
 - 3. LA Pierce College – LED Type, 10 years warranty on LED and Driver, Deco
 - 4. LA Southwest College – LED (Lamp wattage to match existing)
 - 5. LA Valley College – LED
 - 6. West LA College – LED Type, 10 years warranty on LED and Driver

2.03 PARKING LOT FIXTURES

- A. Kim Lighting, Prudential, Gullwing LED
- B. Campus Standards
 - 1. East LA College – Philips, Gardco, Gullwing LED GL13 & GL18
 - 2. LA Harbor College – LED
 - 3. LA Mission College – LED, 10 years, warranty on Led and Driver
 - 4. LA Southwest College – Philips, Gardco, Gullwing LED GL13 & GL18
 - 5. LA Trade Tech College – LED by GE, Lithonia, ASL
 - 6. LA Valley College – Philips, Gardco, Gullwing LED GL13 & GL18

7. West LA College – LED Type, 10 years warranty on Led and Driver

2.04 EXTERIOR LUMINAIRES AND ACCESSORIES – GENERAL

A. Campus Standards

1. LA Harbor College – LED
2. LA Trade Tech College – Bega Lighting

- B. Listed for wet or damp location as scheduled. Fountain and pool luminaires shall be listed for submersible location to meet depth specified.
- C. Provide low temperature LED drivers, with reliable starting to -20°F.
- D. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115°F. Compartment separation of wire entry and control gear/lamp chamber.

2.05 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 90 and color temperature of 3500 K.
- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- D. Luminaire minimum lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.
- E. Photometry for LED luminaire to follow IES recommendations for testing.
- F. LED products shall have minimum 5 years warranty.
- G. LED Driver:
 1. Solid state driver with integral heat sink. Driver shall have over heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Surge suppression device for all exterior luminaires.
 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type.
 3. Driver shall have a minimum of 50,000 hours rated life.

2.06 ACCEPTABLE MANUFACTURERS - POLES

- A. Manufacturer of Luminaire.
- B. Valmont Poles.
- C. U. S. Pole Company.
- D. KW Industries

2.07 LIGHTING POLES

- A. Metal Poles: Round straight steel lighting pole with embedded anchor base.
- B. Prestressed Concrete Poles: Round straight lighting pole with embedded anchor base.
- C. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.

- D. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.
- E. Pole Top: Provide mast arm(s) in array as indicated.
- F. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.
- G. Vibration Damper: Canister or snake type second mode vibration damper internal to the pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head poles where recommended by manufacturer.

2.08 SUBSTITUTIONS

- A. Prior approval is a procedure for substitution of products before issuance of bid documents. These substitutions may be requested by the bidder, contractor, subcontractor, manufacturer, or other qualified party who wishes to propose use of an alternate product in lieu of that specified.
 - 1. The prior approval request shall include sufficient data so that direct comparison of a proposed product to a specified product can be made.
 - 2. If a prior approval request is received (before issuance of bid documents), the request will be reviewed at the specifier's discretion. Inadequate warranty, vagueness of submittal, failure to meet project requirements, or insufficient data may be cause for disapproval or rejection of request.
 - 3. Upon review, the Luminaire Schedule will be updated to reflect the accepted alternates.
- B. Any alternate product not listed on the Luminaire Schedule as shown in the Drawings at the issuance of bid documents shall be formally submitted to the design team as a substitution request. Refer to other Sections of these Specifications for substitution requirements.

2.09 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Structural members to which **equipment and** luminaires will be attached.
 - 3. Underground utilities and structures.
 - 4. Existing underground utilities and structures.
 - 5. Above-grade utilities and structures.
 - 6. Existing above-grade utilities and structures.
 - 7. Building features.
 - 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
 - 1. Luminaire.
 - 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

2.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires **and photoelectric relays** to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide driver and light engine replacement installation instructions as applicable.
 - 3. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

2.11 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: **One for every 100** of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: **One for every 100** of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: **One for every 20** of each type and rating installed. Furnish at least one of each type.

2.12 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 - 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- E. Mockups: For exterior luminaires, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

2.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

2.14 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

2.15 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: **5** year(s) from date of Substantial Completion.

END OF SECTION

SECTION 26 56 68
EXTERIOR ATHLETIC LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Athletic Field luminaires and accessories
- B. Interior Athletic luminaires and accessories
- C. Blackout shutters indoor applications
- D. Mounting hardware indoor applications
- E. Poles outdoor applications
- F. Wireless lighting control

1.02 RELATED REQUIREMENTS:

- A. Section 260500 "Common Work Results for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.03 DEFINITIONS

- A. CCT: Correlated color temperature
- B. CRI: Color rendering index
- C. LLF: Light loss factor

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Athletic Field
 - 1. Musco, Morris, Lithonia
 - 2. Campus Standards
 - a. East LA College and Southgate Environmental Center – Musco, Morris, Lithonia
 - b. LA Harbor College – Musco
 - c. LA Mission College – Lithonia
 - d. LA Pierce College – Musco, Lithonia
 - e. Southwest LA College – Musco

- f. LA Trade Tech College – Musco
- g. LA Valley College – Musco, Morris, Lithonia
- h. West LA College – Not Allowed.

B. Outdoor

- 1. Musco
- 2. GE Sports Lighting Powerspot III New glare 'SLOG' with Spill/Glare control.
- 3. Qualite PRO-Series with Spill/Glare control.
- 4. Hubbell Sportsliter System SLS series with Spill/Glare control.

C. Indoor:

- 1. WideLite Arena Eclipse II with Shutter System.
- 2. Sterner Para II with motorized shade.

2.02 GENERAL

- A. Manufacturer shall have a minimum of 5-years' experience in the design, manufacturing, and installation support of their sports lighting system.
- B. Sports lighting system shall be ETL or UL listed as a complete system.
- C. Outdoor Fixtures and structural system shall withstand 100 mph constant wind forces with a 1.3 gust factor without misalignment to crossarms or individual fixture aiming.
- D. Manufacturer shall provide a minimum of 5-year warranty, from date of Owner accepted installation, against defects in material. All parts and labor to replace will be at no cost to the Owner. The alignment/aiming of individual fixtures shall be warranted against any movement over this same 5-year period.
Lamps shall be warranted for two years from date of Owner accepted installation. Lamps failed within this time shall be replaced and installed at no cost to the Owner by the sports lighting manufacturer.

2.03 PERFORMANCE DESIGN CRITERIA

A. Outdoor

- 1. Calculations for Outdoor Baseball Fields, Football Fields, Soccer Fields, and Tennis Courts:
 - a. Photometric analysis shall state the maintained horizontal footcandle level at 3' above playing field level using a 20' x 20' grid. Test points shall include the sidelines and endline.
 - b. The average maintained horizontal light level shall have a maximum to minimum ratio of 2:1 or less.
 - c. Calculations shall include a light loss factor. The light loss factor, LLF, shall be the combination of the lamp lumen depreciation, LLD, and the luminaire dirt depreciation, LDD. For calculations, use a LDD=0.90. The LLD shall be determined by the lamp manufacturer's stated mean lumens at 40% rated life divided by the 100 hour burn in initial lumens.

For example: The new GE Lighting High Output 1500W multi-vapor universal burn 'Sportstar' has the following initial and mean lumen ratings:

	Vertical	Horizontal	45°
Initial Lumens	178,000	170,000	160,000
Mean Lumens	160,000	140,000	145,000
LLD (mean/initial)	0.899	0.824	0.906
(x)LDD	0.90	0.90	0.90
LLF	0.81	0.74	0.82

- d. Calculations shall state the final design lumens used per fixture. The final design lumens are calculated by multiplying the 100 HR initial lamp lumens by the light loss factor (LLF).
- e. Include "spill light" calculation showing maintained horizontal and vertical footcandles at 3' above grade along the property line.
- f. Calculations shall include Maximum-to-Minimum Ratio, Coefficient of Variation, and Uniformity Gradients as defined by the Illuminating Engineering Society of North America.

2. Outdoor Lighting System Levels

- a. Class I: competition play before a large group (5,000 or more spectators)
- b. Class II: Competition play with facilities for up to 5,000 spectators
- c. Class III: Competitions play with facilities for up to 2,000 spectators
- d. Class IV: Competition or recreational play only (limited or no provision for spectators)

FACILITY	CLASS			
	I	II	III	IV
College	X	X		
Sports Clubs	X	X	X	
Training Facilities			X	X
Recreational Event				X

- e. Outdoor Baseball and Softball Fields:
 - 1) IESNA RP-6, Class: I.
 - 2) Horizontal Illuminance:
 - a) Infield: 150 FC
 - b) Outfield: 100 FC
- f. Outdoor Football Fields:
 - 1) IESNA RP-6, Class: I.

- 2) Horizontal Illuminance: 100 FC
- g. Outdoor Soccer Fields:
 - 1) IESNA RP-6, Class: II.
 - 2) Horizontal Illuminance: 50 FC
- h. Outdoor Tennis Courts:
 - 1) IESNA RP-6, Class: I.
 - 2) Horizontal Illuminance: 125 FC

B. Indoor

1. Calculations for Indoor Basketball, Soccer – Arena Football, and Volleyball:
 - a. Photometric analysis shall state the maintained horizontal footcandle level at 3' above playing field level using a 10' x 10' grid.
 - b. The average maintained horizontal light level shall have a maximum: minimum ratio of 2:1 or less.
 - c. Calculations shall include a light loss factor. The light loss factor, LLF, shall be the combination of the lamp lumen depreciation, LLD, and the luminaire dirt depreciation, LDD. For calculations, use a LDD=0.90. The LLD shall be determined by the lamp manufacturer's stated mean lumens at 40% rated life divided by the 100 hour burn in initial lumens.

For example: The new GE Lighting High Output 1500W multi-vapor universal burn 'Sportstar' has the following initial and mean lumen ratings:

	Vertical	Horizontal	45°
Initial Lumens	178,000	170,000	160,000
Mean Lumens	160,000	140,000	145,000
LLD (mean/initial)	0.899	0.824	0.906
(x)LDD	0.90	0.90	0.90
LLF	0.81	0.74	0.82

- d. Calculations shall state the final design lumens used per fixture. The final design lumens are calculated by multiplying the 100 HR initial lamp lumens by the light loss factor (LLF).
 - e. Calculations shall include Maximum-to-Minimum Ratio, Coefficient of Variation, and Uniformity Gradients as defined by the Illuminating Engineering Society of North America.
2. Lighting System Levels:
 - a. Indoor Basketball:
 - 1) IESNA RP-6, Class: I.
 - 2) Horizontal Illuminance: 125 FC
 - b. Indoor Volleyball:

- 1) IESNA RP-6, Class: II.
- 2) Horizontal Illuminance: 75 FC
3. Indoor: Calculations for Work Lighting:
 - a. Photometric analysis for Work Lighting shall be sub-divided into three areas: the Arena floor, the north and south side of seating areas, and the west end seating area.
 - b. The maintained horizontal footcandle level for the seating areas shall be measured at seat level on the sloped incline using a 10'x10' calculation grid. The average maintained horizontal light level shall not be less than 15 foot-candles with a maximum: minimum ration of 4:1or less.
4. Indoor: Calculations for House Lighting:
 - a. Photometric analysis for House Lighting shall be sub-divided into three areas: the Arena floor, the north and south side of seating areas, and the west end seating area.
 - b. The maintained horizontal footcandle level for the seating areas shall be measured at seat level on the sloped incline using a 10'x10' calculation grid. The average maintained horizontal light level shall not be less than 10 footcandles with a maximum: minimum ratio of 3:1 or less.
5. Indoor: Calculations for Emergency Lighting (Portion of the House Lighting on Emergency)
 - a. Photometric analysis for Emergency Lighting shall be sub-divided into three areas: The Arena floor, the north and south side of seating areas, and the west end seating area.
 - b. The maintained horizontal footcandle level for seating areas shall be measured at seat level on the sloped incline using a 10'x10' calculation grid. The average maintained horizontal light level shall not be less than 3.0 foot-candles with a maximum: minimum ration of 3:1 or less. The minimum at any meter point shall not be less than 1.5 footcandles.
 - c. Emergency Lighting shall be provided within 30 seconds of power failure. Duration of emergency illumination shall be not less than 15 minutes.
6. Both outdoor and indoor Luminaire Mounting Height: Comply with recommendations in IESNA RP-6, Section 3.

2.04 FIXTURES

- A. Outdoor: The sports floodlights optical assembly shall be a one piece spun aluminum parabolic type reflector finished inside and out with a corrosion resistant anodized finish for maximum optical performance and lumen maintenance.
- B. Indoor: The arena sports floodlights, Type A1, optical assembly shall be a multi-segmented aluminum reflector with 95% reflective specular finish. Manufacturer to determine proper optical assembly beam pattern to achieve performance criteria.
- C. Outdoor: The optical assembly shall include a thermal and impact resistant glass lens in a stainless steel hinged doorframe. The doorframe shall be permanently attached to the reflector by the stainless steel hinge and held in place with stainless steel spring latches. The doorframe shall include a concentric butt-welded high temperature solid silicone gasket. The reflector shall also include a granular charcoal filter to protect the internal reflective surface from photometric degradation caused by the entry of dust and other fine particulate.

- D. Indoor: The optical assembly shall include a thermal and impact resistant glass lens in an aluminum doorframe. The doorframe shall be permanently attached to the reflector by screws. The doorframe shall include a concentric butt-welded high temperature solid silicone gasket. The reflector shall also include a granular charcoal filter to protect the internal reflective surface from photometric degradation caused by the entry of dust and other fine particulate.
- E. The optical assembly shall include a thermal resistant, vibration dampening lamp support positioned opposite of the lamp base so as to not interfere with light distribution. This support will dampen vibrations, which otherwise would decrease overall lamp life and maintain proper position of lamp within reflector.
- F. Outdoor: All fixtures mounted on the sideline poles shall be provided with means to minimize glare and spill lighting. Use of internal louvers and/or external visors shall be securely assembled to the optical housing.
- G. Indoor: All arena sports floodlights shall include a total blackout motorized shutter or shade system. This shutter/shade system shall provide no light leak when closed and maintain 100% lights output. Shutter system can remain closed indefinitely without excessive heat build-up. Shutter shall close/open in less than three (3) seconds and include a fail-safe lamp extinguishing relay to turn off lamp if the shutter would not close to ensure a dark arena when required. Shutter shall not interfere with photometric distribution of the fixture. Power for the motorized shutter/shade via 120-volt ballast tap from the remote ballast.
- H. All sports floodlights and work floodlights shall utilize the same 1500-watt metal halide lamp source for consistency in relamping and maintenance. Each fixture shall have a lockable aiming mechanism that will allow fixture to be rotated for relamping and repositioned without reaiming.
- I. Outdoor: The sports floodlights shall mount to the crossarms with a fully adjustable mounting bracket to allow aiming of fixture. The ballast assembly shall be remote from the fixture in a separate enclosure mounted near the base of the pole (10 feet above grade). Wiring between the remote ballast enclosure(s) and fixtures shall be via a wiring harness located within the pole.
- J. Indoor: The sports floodlights and work floodlights shall mount to the catwalk railings with a fully adjustable mounting bracket to allow aiming of fixture. The ballast assembly shall be remote from the fixture in a separate enclosure mounted to the same fixture mounting bracket supported to catwalk. Wiring between the remote ballast enclosure and fixture shall be via a cord and modular plug for both lamp and motorized shutter. Ballast also shall include 6' cord and locking plug for 277-volt operation.
- K. Indoor: The Work floodlights, Type A2, are separate from the Arena sports floodlights and are controlled all on/off only for clean up or set up work mode. The work floodlights will not have a shutter/shade system and cannot be used to supplement the sports floodlights.
- L. Indoor: The House floodlights, Type A3, are separate from both the Arena sports floodlights and Work floodlights and are controlled through the House dimming system. A portion of the House floodlights shall be an emergency power to yield emergency lighting of the Arena per the performance criteria.
- M. Indoor: In addition to each fixture being supported from the mounting hardware, the manufacturer shall supply stainless steel safety aircraft cable to support the fixture independently to the catwalk railing.

- N. All wiring on the Luminaire assembly shall meet National Electric Code and shall pass from each Luminaire on the assembly through protective enclosures to join in a common enclosure. Each luminaire shall have individual supplemental fuse protection located in remote ballast boxes. Fusing must be UL listed. In-line is not acceptable.

2.05 OUTDOOR: WIRING HARNESS

- A. The wiring harness between the fixtures and remote ballast enclosure(s) shall be multi-conductor type cable with an overall outer PVC jacket for physical protection. Minimum conductor size shall be #14AWG with individual color-coated insulation jacket to facilitate any troubleshooting. All conductors shall be stranded copper with 600-volt insulation with 90°C temperature rating.
- B. In addition to the outer PVC jacket around the multiple conductors, provide rubber bumpers spaced no greater than 10' on-center to minimize possible abrasion of outer PVC jacket on interior finish of pole.
- C. Include stainless steel wire mesh strain relief at top of wiring harness and secure to inside top of pole.
- D. Each end of wiring harness shall have a quick connector plug for ease of installation.
- E. Each wiring harness shall be tested at the factory to verify proper operation between ballast and fixture and to minimize field installation time.

2.06 OUTDOOR POLES

- A. Comply with AASHTO LTS-3 for poles or other support structures, brackets, arms, appurtenances, base, anchorage, and foundation.
- B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires without failure, permanent deflection, or whipping in steady winds of 100 mph with a gust factor of 1.3.
- C. Mountings, Fasteners, and Appurtenances: Corrosion resistant, compatible with support components, and shall not cause galvanic action at contact points.
 - 1. Steel Components: Hot-dip galvanized after fabrication, complying with ASTM A 123 / A 123M.
 - 2. Mounting Hardware Fasteners: Hot-dip galvanized, complying with ASTM A 153 / A 153M.
- D. Poles shall be sectional type hot dipped galvanized steel poles to achieve minimum fixture mounting height specified. All poles shall include grounding lug, wire access handhole, remote ballast enclosure(s) mounting brackets and wiring access, lightning terminal atop pole, and jacking brackets. Contractor/Manufacturer may use prestressed centrifugally spun concrete poles meeting all structural requirements at their discretion.
- E. Pole base may either be a prestressed centrifugally spun concrete base pier or direct embedded hot dipped galvanized steel pole with black tar coating entire embedded length or a poured in place foundation concrete base.

- F. The foundation for either prestressed concrete base or base plate steel pole shall be designed around standard auger sizes with concrete fill to achieve a minimum 28-day compression strength of 3000 psi or greater as required by manufacturer's structural design analysis. Crushed rock or earth backfill is not acceptable!
- G. The sports lighting system manufacturer shall provide complete calculations within submittals verifying that the lighting pole meets the wind load requirements specified herein.
- H. The sports lighting structure system shall be designed to withstand an Isotach wind velocity of 90 mph plus a 1.3 gust factor, including the total effective projected area and weight of the fixtures and complete assembly. The loads computed by this method shall not be less than those based on 1 90 mph wind with an exposure "B" per International Building Code 2000 and ASCE 7-98.
- I. Sports lighting system manufacturer shall provide complete calculations within submittals verifying that the lighting pole meets the wind load requirements specified herein.
- J. Each section of the pole shaft shall be of a single ply of steel with no welded splices and having only one longitudinal seam weld. Each slip joint shall be assembled in the field by slipping the upper section over the lower section by a minimum lap of 1.5 times the largest inside diameter of the upper section. The pole cross section shall be rounded or 16-sided with a four-inch corner radius. The pole shaft sections shall be high strength steel meeting the requirements of ASTM A595 Grade A or B or ASTM A572 Grade 65.
- K. Poles shall be hot-dipped galvanized in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- L. Each pole shall include a ½" diameter by 48" tall solid copper lightning protection air terminal with nickel plated tip.
- M. Crossarms shall be fabricated from hot dipped galvanized tubular steel. All mounting brackets and hardware shall be galvanized to ASTM A123 requirements.
- N. Manufacturer of sports lighting structure shall receive soil tests from Owner to properly design pole foundations.
- O. Manufacturer shall include cost to hire the services of a licensed Structural Engineer to review soil tests and design appropriate pole foundations. Include signed foundation drawings, calculations and all installation requirements in sports lighting system submittal.
- P. The poles shall have a 1" diameter grommet drilled in the pole shaft, prior to galvanizing, and furnished with a rubber plug for future speaker wiring access. This grommet shall be located approximately 12" below the externally mounted cross-arm or bracket and shall be suitable for supporting up to 4 speakers.

2.07 INDOOR: MOUNTING HARDWARE

- A. Manufacturer to provide complete mounting system for all arena sports lighting, work lighting and house lighting fixtures. The mounting system bracket shall be supported from a minimum of two (2) railings on the catwalk and be capable of stacking two fixtures, one above the other.
- B. Mounting bracket shall utilize cantilevered arms to hold fixtures out from the catwalk railing and allow for complete tilt and rotation of fixtures even when double stacked. Spacing and length of arms shall not restrict the aiming or relamping of fixtures.

- C. Mounting system shall include provisions for mounting remote ballast enclosures on a Z-spline bracket located on the catwalk side of the mounting system.
- D. The mounting system hardware shall be capable of supporting up to a minimum of 500 lbs.

2.08 WIRELESS LIGHTING CONTROL

- A. Manufacturer to provide wireless lighting control to manage, monitor and control all sports lighting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical and communications conduit to verify actual locations of connections before pole or luminaire installation.
- C. Examine foundations for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
 - 1. Nonstandard or Custom Luminaire Drawings, Diagrams, and Supporting Documents:
 - a. Include plans, elevations, sections, and mounting and attachment details.
 - b. Details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Diagrams for power, signal, and control wiring.

3.03 INSTALLATION OF ATHLETIC FIELD LIGHTING

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Luminaires and Lamps: Article 410 of NFPA 70.
 - 2. Consult **Architect** for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Athletic Field Luminaires:
 - a. Install luminaires at height and aiming angle as indicated on Drawings.

- b. Install controls in cabinets mounted on support structure at least **10 ft** above finished grade.
 2. Structural Supports:
 - a. Provide **steel or aluminum** poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations for athletic field lighting.
 - b. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
 - c. Install poles and other structural units level, plumb, and square.
 - d. Except for embedded structural members, grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole. Nonshrink grout is specified in Section 055000 "Metal Fabrications."
 - e. Extend cast-in-place bolted base foundations **36 inch** above grade, minimum.
 3. Wiring Methods:
 - a. Install cables in raceways, except when cables are installed within boxes and poles. Conceal raceways and cables.
 - b. Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; 10 AWG minimum conductor size for power wiring.
 - c. Electrical Enclosures Exposed to Weather: UL 50E, Type 3R enclosure constructed from **stainless steel**, with hinged doors fitted with padlock hasps or lockable latches.
 - d. Install lighting control equipment and cabling connections to luminaires.
 4. Identification: Provide labels for athletic field lighting and associated electrical equipment.
 - a. Identify system components and terminals.
 - b. Identify field-installed conductors, interconnecting wiring, and components.
 - c. Provide warning signs.
 - d. Label each enclosure with engraved metal or laminated-plastic nameplate.
- D. Interfaces with Other Work:
1. Coordinate installation of new products with existing conditions.
 2. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
 3. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard inside equipment.
- E. Systems Integration: Integrate athletic field lighting controls with facility lighting controls.
- 3.04 FIELD QUALITY CONTROL OF ATHLETIC FIELD LIGHTING
- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:

1. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
 2. Playing and Other Designated Areas: Make field measurements at intersections of grids, dimensioned and located as specified in "Performance Requirements" Article
 3. Verify that grid sizes and number of measurements stated in first six subparagraphs below are adequate for Project and relate to Project boundaries.
 4. Make field measurements at established test points in areas of concern for spill light and glare.
 5. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
 6. Report results in writing.
- C. Nonconforming Work:
1. Sports lighting will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
 3. Correction of Illumination Deficiencies for Playing Areas: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent.
 - a. Add or replace luminaires; change mounting height and aiming; or install louvers, shields, or baffles.
 - b. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
 - c. Do not replace luminaires with units of higher or lower wattage without Architect's approval.
 - d. Retest as specified above after repairs, adjustments, or replacements are made.
 - e. Report results in writing.
- D. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.
1. Replace luminaires; change mounting heights and revise aiming; or install louvers, shields, or baffles.
 2. Obtain Architect's approval to replace luminaires with units of higher or lower wattage.
 3. If mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
 4. Retest as specified above after repairs, adjustments, or replacements are made.
- E. Assemble and submit test and inspection reports.
- 3.05 SYSTEM STARTUP
- A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions
- B. Manufacturer Services: Engage factory-authorized service representative to **supervise** system startup.
1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.
- 3.06 ADJUSTING
- A. Adjust luminaires and supports to maintain orientation and aiming as recommended by manufacturer.
- 3.07 PROTECTION
- A. After installation, protect athletic field lighting and associated electrical equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.
- 3.08 MAINTENANCE
- A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes **12 months'** full maintenance by **skilled employees of athletic field lighting Installer**. Include **annual** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper athletic field lighting operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION

DIVISION 27

COMMUNICATIONS

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SECTION 27 00 00
COMMUNICATIONS BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements.

1.2 GENERAL PROJECT INFORMATION

- A. The design-build team should provide a compliance letter with a statement of being fully compliant with Campus standards and requirements for the campus as part of the final submission documentation to the district. The design-build team should follow the latest District Design Guidelines and standards.
- B. This district-wide design standard and the accompanying specifications govern the work involved in furnishing, installing, testing, and placing into satisfactory operation the Communications Systems as specified herein.
- C. The contractor is to provide all new materials as indicated on the drawings, and/or in these specifications, and all items required to make their portion of the Communications Systems a finished and working system.
- D. For a complete list of material for each campus where work is performed.
- E. Project Description
 - 1. These Specifications and associated drawings are the governing document for the installation of the telecommunications infrastructure and include project descriptions, specified and recommended products, installation and project management methods, the scope of work, and elevation drawing specifications.
- F. Scope Summary description of Communications Systems include but are not limited to the following:
 - 1. Complete Structured Cabling System including, but not limited to:
 - a. Voice and data backbone cabling and terminations.
 - b. Voice and data horizontal cabling and terminations.
 - c. Information outlets (IO's) including faceplates, jacks, and labeling.
 - d. Equipment racks, cabinets, cable management, and equipment.
 - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
 - f. Cabling pathways.
 - g. Grounding and Bonding
 - h. Testing

2. Complete Data Communications Equipment Systems.
3. Complete Voice Communications Equipment Systems.
4. Complete Audio/Visual Systems.
5. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
6. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies are required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
7. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
 - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
 - b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
 - 1) C.1 - Commercial Building Telecommunications Standard
 - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 3) C.3 - Optical Fiber Cabling Components Standard
 - c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
 - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
 - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
 - g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard
 - h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers
 - i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - j. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
 - k. NFPA 70 (NEC) - National Electrical Code (Current Edition)
 - l. UL 444 - Standard for Safety for Communications Cable

- m. LACCD facilities Design standards cabling Telecommunications Ver2-February 2017
8. Bid Proposals
- a. Add/Delete prices must reflect the cost for adding outlet location Pre-Installation and Post-Installation.
 - b. The proposal shall include a complete Schedule of Values including the following items:
 - 1) All materials being proposed.
 - 2) Unit quantities for all materials
 - 3) Unit pricing for all materials
- G. Scope of Work:
- 1. General
 - a. The following Scope of Work is meant as a guideline for this project. Acceptable and recommended products, installation methods, project timelines, and Contractor responsibilities are detailed in other sections of this document.
 - b. It is the responsibility of the Contractor awarded this project to ensure that all quantities, materials, labor, permits, sales taxes, and any other costs to provide a turnkey project are included in their bid. Omissions on the part of the Contractor, either due to misinterpretation of this contract specification, the bid documents, or any other conditions of the project will be the responsibility of the Contractor and not result in any contract modification or additional costs to the Owner.
 - c. Floor plans, BDF Room and IDF Room drawings, elevation drawings, and other drawings received by the Contractor as part of the bid process are hereby incorporated into this document by reference. It is the responsibility of the Contractor to ensure that amounts and lengths of cabling and pathways are correct and that all materials and labor are included to install the system per the drawings and these specifications.
 - d. It is the responsibility of the Contractor to ensure that all materials and methods comply with all conditions of these specifications.
 - e. All materials required to provide a turn-key cabling infrastructure are to be provided and installed by the Contractor as part of this Scope of Work. Any item of equipment or material not specifically addressed on the drawings, specifications, or elsewhere in this document, but required to provide complete and functional systems as contemplated and/or specified herein, shall be provided at no additional charge to the owner in a quantity and quality consistent with other specified items.
 - f. The Contractor is responsible for ensuring the timely completion of the project based on the provided project timeline and is responsible for an investigation of any issues, including delivery, local licensing, and union, that might affect in any manner the scheduled installation of this project.
 - g. The Contractor is responsible to ensure all debris caused by drilling, saw cutting, filing, etc. are vacuumed daily to prevent potential injury to others and possible damage to electronic equipment.
 - h. The Contractor is responsible to maintain a clean work environment, all trash and debris caused by such contractor shall be picked up daily per general contractor requirements, terms, and conditions.

- i. Non-compliance with these conditions will result in the removal of any portion, not in compliance, and replacement at the expense of the Contractor per these Contract Conditions.
- j. A minimum of (1) complete copy of this Scope-of-Work/Specifications must be kept in the field at all times for the duration of the project build-out for reference by the Contractor's installation crew, managers, and the Owner.
- k. The division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including the said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed as an additional cost for the scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

H. Definitions:

- 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of the Specification.
- 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of the specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
- 3. "Communications Contractor" as referred to herein refers to the Contractors listed in Division 27 of the Specification.
- 4. Low Voltage Communications Wiring: The wiring (less than 120VAC) associated with the Communications Systems, used for analog and/or digital signals between equipment.
- 5. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings, and other miscellaneous hardware required for the installation and mounting of the telecommunications information outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling the nearest cable tray. Where surface mounted backboxes are required, the conduit shall be routed to above the lay-in ceiling the bottom of the exposed structural joists the nearest cable tray.

I. Miscellaneous:

- 1. The purpose of these standards is to outline typical Electrical and Communications contractors' work responsibilities as related to Communications Systems including Telecommunications rough-in, conduit, cable tray, power wiring, and Low Voltage Communications Wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Communications Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Communications Drawings but required for the successful operation of the systems shall be the responsibility of the Communications Contractor and included in the Contractor's bid.
 3. Where the Electrical Contractor is required to install conduit, conduit sleeves, and/or power connections in support of Communications systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Communications Contractor has convened to determine the exact location and requirements of the installation.
 4. Where the Electrical Contractor is required to install a cable tray that will contain Low Voltage Communications Wiring, the installation shall not begin until the Communications Contractor has completed a coordination review of the cable tray shop drawing.
 5. This Contractor shall establish Electrical and Communications utility elevations prior to fabrication and installation. The Communications Contractor shall cooperate with the Electrical Contractor and the determined elevations per the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate
 - c. Sheet Metal
 - d. Electrical Busduct
 - e. Cable Trays, including 12" access space
 - f. Sprinkler Piping and other Piping
 - g. Conduit and Wireway
 - h. Open Cabling
- J. Electrical Contractor's Responsibility:
1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
 2. Assumes all responsibility for providing and installing a cable tray.
 3. Responsible for Communications Systems grounding and bonding.
 4. This Contractor is responsible for the coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.
- K. Communications Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Communications Wiring of all systems, including cable support where the open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit, and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Communications equipment which is required to be bonded to the Communications ground system.
5. This Contractor is responsible for the coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

L. Coordination Drawings General Requirements:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative for approval prior to the start of work. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop-drawings and shall not be submitted as such. The contractor shall be responsible to produce and submit shop drawings for approval from the campus and/or A/E.
4. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
5. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings, or changes of duct size, which are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
6. The A/E reserves the right to determine the space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
7. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
8. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

- d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
- 9. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
 - 10. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
 - 11. Updated coordination drawings that reflect as-built conditions may be used as record documents.

M. Qualifications:

- 1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
- 2. The installing contractor shall have at a minimum a C-10 License and be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding on this project. Documentation of certification is required at the time of the bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
- 3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
- 4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
- 5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
- 6. The Contractor must have an active RCDD (Registered Communications Distribution Designer) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD.
- 7. The Contractor shall have certified BICSI installation technicians on staff to perform the following tasks on the project:
 - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
 - b. Oversee all testing and termination of cabling.
- 8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:

- a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
 - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
 - d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
 - e. Resume and certification of the RCDD for the project as required by the form at the end of this specification section.
 - f. Resume and certification of the BICSI installation technician for the project.
- N. Compliance with Codes, Laws, Ordinances:
1. The Contractor shall conform to all requirements of the City of Los Angeles Codes, Laws, Ordinances, and other regulations having jurisdiction over this installation.
 2. The Contractor shall also conform to all published standards of the Los Angeles Community College, as related to this installation.
 3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes, and regulations shall determine the method or equipment used, otherwise the contractor shall be responsible to provide products specified where required.
 4. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
 5. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
- O. Warranty requirements at a minimum shall provide a five (5) year service warranty for all equipment, materials, and workmanship. Individual specifications sections may require additional warranty requirements for specific equipment or systems.
- P. Warranty requirements for CAT-6A and Fiber cabling shall be at a minimum of twenty-five (25) years. Cabling manufacturers shall not be mixed in order to maintain the warranty.
- Q. The contractor shall be responsible to provide a maximum 4-hour response time for servicing or replacing any equipment or devices installed for the project.

- R. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such a whole system, partial system, or a separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- S. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or non-conforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.
- T. Where several manufacturers' names are given, the first-named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used per the contract.
- U. Equivalent equipment manufactured by the other named manufacturers may be used. The contractor shall be responsible to provide a side by side comparison chart for approval, this will not constitute the replacement of specified items. The contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is an equivalent.
- V. Any material, article, or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article, or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturer's equipment adequately meeting the intent of the design. The Architect/Engineer may reject the manufacturer at the time of the shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment, or installation method.
- W. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article, or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.
- X. Installation requirements shall be adhered to as follows. Installation of all conduits and cabling shall comply with Div. 26 specifications as required. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Electrical Section 26 05 33. Conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- Y. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

- Z. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling, and furnishings prior to the start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- AA. The Contractor shall conduct all tests required and applicable to the work both during and after the construction of the work.
1. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who have been schooled in the proper testing techniques.
 2. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
 3. All telecommunications tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.
 4. Application of foreign materials of any kind on any cable, cable jacket, or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the Local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.
- AA. Before final payment will be authorized, this Contractor must have completed the following:
1. Submitted operation and maintenance manuals to the Architect/Engineer for review and final approval. The contractor will be responsible to provide any additional forms or documentation required by the District as applicable to the project
 2. Submitted bound copies of approved shop drawings for district record keeping. Such drawings shall be provided in the original condition as to when they were approved.
 3. A clean set of record documents including edited drawings and specifications accurately reflecting field conditions, inclusive of all project revisions, change orders, and modifications.
 4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.

5. Submitted testing reports for all systems requiring final testing as described herein in native and electronic PDF format and provide manufacturer software.
 6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
 7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site insert address here; submit the receipt to Architect/Engineer prior to final payment being approved.
- BB. Provide adequate instructions to the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- CC. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- DD. (3) hard copies of all deliverables shall be provided in a 3-ring binder. Soft copies of all deliverables shall be provided on an MP4 USB thumb drive. Must provide (2) thumb drives. The contractor where required shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- EE. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desired.
- FF. At a minimum, the contractor shall provide (4) hours of instruction time for each system or as specified and requested by the owner. Verbal requests shall not constitute the minimum time required for instruction. A written statement shall be provided to document the time of instruction.
1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
 2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care, and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.
- GG. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

- HH. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for troubleshooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues, or unsatisfactory system performance, including callbacks during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation, or workmanship related. Payment is due within 30 days after services are rendered.
- II. This Contractor shall maintain at the job site, a separate and complete set of Communications Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Communications Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications, and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- JJ. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- KK. Upon completion of the job, and before final acceptance, This Contractor shall give the complete close-out documents to the Architect/Engineer.
1. Fiber and Copper Test results. Testers shall be calibrated 30 days prior to testing.
 2. Updated rack elevations after all equipment have been installed.
 3. Unique cable identifier for all installed communications cabling.
 4. Main pathways must be identified.
 5. All wireless access points must have the customer's AP # and MAC# included along with the unique cable number. Additional information shall be coordinated with the District Representative.
 6. Fiber Backbone, Copper Backbone and Horizontal Cables Schedule - Patching Matrix Spreadsheet.
 7. As-built drawings shall be provided by the contractor at two stages of the project.
 - a. Handwritten work in progress mark-ups of floor plan drawings showing all cable locations with the unique cable identification shall be delivered 4-weeks prior to the move-in date.
 - b. Electronic As-built drawings in Revit/CAD and PDF files shall be provided and delivered to the Owner and Owners Representative no more than five days after move-in.
 - c. One hard copy of the completed as-built drawings (floor plans only) shall be mounted within the BDF and IDF Rooms.
 - d. Additional hard copies may be requested by the Owner during the course of the project. All such requests shall be granted at no cost to the Owner.
 8. Warranty and Operations & Maintenance Documentation.
 - a. Workmanship Installation warranty.
 - b. Manufacturer performance warranty.
 - c. Manufacturer cut-sheets.
 9. Transmittal for non-installed equipment and accessories:
 - a. Patch cables
 - b. Passive hardware

PART 2 – PRODUCTS

1.1 NOT USED

PART 3 – EXECUTION

1.1 NOT USED

END OF SECTION

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SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional structured high-performance copper and optical fiber communications cabling system. The instructions in this section are specific to communications installations and should be read in conjunction with other contract documents as applicable.
- B. Where there are discrepancies between the drawings and the specification, herein, and related specifications sections, the Contractor shall be responsible for providing the more onerous solution.

1.02 RELATED SECTIONS

- A. 27 05 28 – Pathways for Communications Systems
- B. 27 08 00 – Commissioning of Communications
- C. 27 11 00 – Communications Equipment Room Fittings
- D. 27 15 00 – Communications Horizontal Cabling
- E. 27 16 00 – Communications Connector Cords, Devices and Adapters

1.03 QUALIFICATIONS

- A. The communications cabling system installation work detailed in this section shall be carried out by a specialist installer company. The installer shall be certified by the system manufacturer (or manufacturers in the installation and testing of the cabling system).
- B. The installer shall have a proven track record in the field of telephone and data (high performance copper and optical fiber) cabling system installation. The installer shall have completed at least three previous installations of comparable size, complexity and manpower within the last three years. Each installation shall utilize components, installation practices and testing procedure equivalent to those specified in this document.

C. The Installer shall hold a valid State Contractors License (if required by the State) for the duration of the project. The Installer shall be responsible for obtaining permits and other requirements for performing work on this project. All costs associated with obtaining permits and other documentation shall be included in the bid sum for the project.

D. The installer shall be a locally registered and approved Certified Installer (CI) and shall be qualified to provide a twenty-five (25) year premium warranty covering products, performance, and applications assurance.

1.04 DEFINITIONS

A. Throughout this specification, the following definitions will apply:

1. Provide: Supply, furnish, deliver, install, pull, fix, dress, terminate, label, test, ground and document the components as per these specifications.
2. Entrance Facility (EF): An entrance to a building for both public and private network service cables, including wireless, mechanical, and electrical services, and the entrance point at the building wall, and continuing to the entrance room or space. Also known as building entrance, demarcation point (demarc) and entrance room or space.
3. Equipment Rooms (ERs), also known as MDF (Main Distribution Frame) Rooms or BDF (Building Distribution Frame) Rooms, are special-purpose rooms that provide space and maintain a suitable operating environment for the termination of backbone and campus cabling and house centralized communications and/ or computer equipment (such as Core Switches and Servers).
4. Telecommunications Rooms (TRs), also known as IDF Closets, Telecommunications Closets or Tele/Data Rooms are floor-serving spaces that provide a connection point between backbone and horizontal distribution pathways.
5. Backbone Cables: Cables interconnecting the Equipment Room (ER) and Telecommunications Rooms (TRs).
6. Link Cables: Cables interconnecting Telecommunications Rooms (TRs).
7. Horizontal Cables: Cables interconnecting the Telecommunications Rooms (TRs) to each workstation outlet.
8. External Cables: Cables that interconnect the building to external connection point(s) and/or other building(s). These cables are considered to be Outside Plant (OSP).
9. Station Cables: Cables linking workstation outlet to active equipment.
10. Client: The Owner, LACCD
11. Construction Manager: TBD
12. Architect: TBD
13. Consultant: TBD
14. Bidder: A company invited to bid for the works

15. Installer/Contractor: The Company installing the equipment as defined in this specification.
16. Owner's Representative: Vantage Technology Consulting Group

1.05 MANUFACTURER'S COMPLETE SYSTEM

- A. The cabling system specified in this document shall be an end-to-end solution that is sourced from a single manufacturer or partnered manufacturers. Unless explicitly noted within these specifications, this shall include patch panels, connectors, cables, patch cords, face plates and other associated components.
- B. Where it is specified that a system be provided by "manufacturer xxx or equal", a substitution of another manufacturer's products will only be considered for a complete end-to-end solution of equal quality, as determined by the Owner's Representative. All substitutions shall conform to the substitution requirements detailed in the specifications. In instances where these specifications do not include the statement "or equal" for a particular component or system, substitutions will not be entertained.

1.06 JOB CONDITIONS

- A. Prior to bidding, visit the site and determine all existing conditions affecting work. The Bidder shall examine all drawings and specifications to familiarize themselves with the type of construction to be used, and the nature and extent of work provided by other trades.
- B. Verify dimensions and the correct location of hardware before proceeding with the installation of hardware, cabling and/or connections.
- C. Contractor to field verify the location of all communications infrastructure and confirm it is in conformance to industry standards. This would include bend radius, pathways accessibility, pathways lengths to MDF/IDF or other conditions that would impair the ability of the contractor to adhere to these specifications.
- D. The contractor shall notify the Owners' Representative in writing via RFI immediately of the discovery of construction discrepancies or other conditions detrimental to proper performance of the Work. In the event the contractor installs systems components that do not meet this specification, it will be the responsibility of the contractor to revise the installation at no cost to the owner.

1.07 PERSONNEL

- A. The personnel who will be employed on the contract shall be suitably trained in the management of a project of this nature and/or in the installation and maintenance of products of the type being provided to be able to carry out all work in a competent manner.

- B. The Installer shall provide a site manager responsible for all site-related issues. This individual shall be the single point of contact for the project team and shall carry a mobile phone so they can be contacted during the working hours of the project.
- C. The Installer shall be certified by the component manufacturer(s) in the installation and testing of the cabling system and shall be able to provide a manufacturers' extended performance warranty for the end-to-end cabling system.

1.08 LABELING AND NUMBERING SCHEME

- A. Labeling of the cabling system shall be in accordance with ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure, unless otherwise directed by the Owner.
- B. The contractor shall submit for approval the proposed numbering scheme prior to removal of any temporary labeling.

1.09 WARRANTY

A. Installation Warranty.

- 1. Installer to provide a warranty for one year from Notice of Completion on all materials and workmanship installed or supplied as part of the cabling system. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.

B. Cabling System Warranty:

- 1. The contractor shall facilitate a 25-year system performance warranty between the manufacturer and the Owner. A component warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of acceptance. The performance warranty shall warrant the installed horizontal copper, and both the horizontal and the backbone optical fiber portions of the cabling.

C. Post Installation Series:

- 2. The contractor shall furnish an hourly rate with the proposal submittal which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall not void the Contractor's nor manufacturer's warranty.

1.10 QUALITY

- A. The Contractor shall be responsible for the complete provision and installation of all components as specified herein. The Contractor shall provide all tools, equipment, fixtures, appliances, ancillary piece parts and hardware as necessary to complete the assembly and installation as required. The Owner's Representative may conduct scheduled or unscheduled inspections of the Contractor's work at any time during construction. All work included in the scope assigned to the contractor that is associated with this project shall be accomplished in a workmanlike manner, installed, and assembled plumb, level and square. The product shall be delivered to the Owner finished, complete, and ready to operate according to the manufacturer's specifications.
- B. All installation work shall be completed to the standard of the samples approved by the Owner's Representative during the submittal process. Any products not installed to the quality detailed in these specifications and approved in the submittal process shall be reworked by the Installer to the satisfaction of the Owner's Representative at no additional cost to the Owner.
- C. All equipment and components shall be installed per the manufacturer's directions and installation instructions. Any products not installed per manufacturer guidelines shall be reworked by the Installer to the satisfaction of the Owner's Representative at no additional cost to the Owner.

1.11 STANDARDS

- A. All materials provided by the Installer shall meet the requirements of the following where applicable:
 - 1. National Electrical Manufacturer's Association (NEMA)
 - 2. American National Standards Institute (ANSI)
 - 3. Underwriters Laboratories, Inc. (UL)
 - 4. Intertek Electrical Testing Labs (ETL)
- B. All products, services and documentation provided by the Installer shall meet the requirements of the following where applicable. Use latest edition or edition adopted by the Authority Having Jurisdiction.
 - 1. National Electric Code (NEC) – NFPA 70
 - 2. National Fire Alarm and Signaling Code - NFPA 72
 - 3. Relevant State Electric and Fire Codes
 - 4. ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - 5. ANSI/TIA-568.1-E Commercial Building Telecommunications Cabling
 - 6. ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components
 - 7. ANSI/TIA-568.3-D Optical Fiber Cabling Components
 - 8. ANSI/TIA-568.4-D Broadband Coaxial Cabling and Components
 - 9. ANSI/TIA-569-E Telecommunications Pathways and Spaces

10. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure
 11. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 12. Manufacturer's design and installation agreements.
 13. LACCD Standards for IT Infrastructure and Technology Systems
 14. Los Angeles City College Campus Standards Matrix dated 08/12/2021 (or latest revision).
 15. BICSI publications:
 - a. Telecommunications Distribution Methods Manual
 - b. Network Design Reference Manual
 - c. Information Transport Systems Installation Manual
 - d. Customer Owned Outside Plant Design Manual
- C. All publications referred to in this document shall be the latest edition.

1.12 SUBMITTALS

A. Project References

1. Submit for approval, references for a minimum of three similar projects successfully undertaken and completed within the last three years. These projects should be a similar scale, complexity and have similar time scales as this project.
2. Provide project name and address, client contact name and telephone number and construction manager name and telephone number. Provide a brief description of each project indicating types of system installed, quantities and configurations of outlets and project time scales.
3. At least two of the references shall be located within 100 miles of the project and shall be available for the Owner's Representative and other members of the Design Team to visit and inspect the installation, should, in the opinion of the Owner's Representative, this be necessary.
4. These references are intended to show that the Installer has successfully completed similar projects. Failure to produce satisfactory references may result in the bid being deemed non-compliant.

B. Product Literature/Data Sheets

1. Submit for approval manufacturer's product data sheets for each component of the telephone and data cabling systems contained within this specification and associated documentation. Certify that the data sheets depict the components to be provided by the Installer to make up the complete system as described in this specification.
2. Submit the required information for all products within a specification Section at one time unless the Owner's Representative has given prior approval to submit information otherwise.

3. Equipment installed and not approved for installation via the submittal process will be replaced at no expense to the Owner.
4. Prior to installation, submit for approval records regarding the management, installation, and testing personnel to be used on the project. These records shall include resumes, training certificates, previous work experience details (especially on reference projects) and other relevant information.
5. Submit records to confirm that the personnel who will be employed in an installation capacity are suitably trained in the installation and maintenance of equipment and systems of the type being provided.
6. Submit records to confirm that the personnel that will be responsible for testing the system are suitably trained in the operation of the test equipment being used in this project.

C. Shop Drawing/Cabling Diagram

1. Submit shop drawings for approval and a complete single-line cabling diagram. The diagram shall be based on the single line drawing included in the Construction Documents and show all ER/MDF, TR/IDF and cable termination points or pass-through locations in the building riser.
2. Single line to be coordinated with building riser diagrams and reflect for record the building conduits used cable quantities in each bundle and conduits with spare capacity.
3. Single line to show quantities and part numbers for all typical components including faceplates, patch panels, cable, equipment racks, splice cases and all other system components.

D. Test Equipment

1. Submit, for approval, details of each item of test equipment to be used to test the optical fiber and copper components. Include patch cords and other specialized components.
2. Submit for approval a written description of the cable (copper/fiber) testing procedure indicating each test to be performed, and the process of correcting any failures prior to commencement testing for approval. Any testing to copper/fiber components performed without an approved test procedure shall be retested at the contractor's expense.
3. Contractor to provide certification of calibration dated within one (1) year of installation date. Any testing to copper/fiber components performed without calibration certification is to be retested upon certification at the contractor's expense.

E. Component Samples and Mock-ups

1. Provide one full size installation sample mock-up of each of the following components for approval. All samples are to be fully labeled as per these specifications. Samples are to be delivered to the Construction Manager's office on site prior to installation.
2. All sample mock-ups are intended to represent the components that are to be installed as part of this project; therefore, they are to be provided with all associated components and labeling necessary to make up a complete mock-up. This will include but not be limited to: Backbox, and 12" span of conduit as specified in the construction documents, cable, jacks, wire ties and any other components that make up an outlet location.
3. Installation shall not proceed until the Owner's Representative has approved the samples. Once samples and other documents have been submitted, inspected by the Owner's Representative, and approved, they shall be retained. The samples will be used as the standards by which the quality of work on the project by the Installer shall be judged. Any installation that does not meet this standard shall be replaced or re-worked as approved by the Owner's Representative, at no cost to the project.
4. Outlet Samples.
 - a. Provide a mock-up of each communications outlet, as listed below. The sample is intended to represent a typical communications outlet and shall include all associated parts to make a complete sample. Provide bushings and strain relief for the horizontal cable jacket, demonstrating how the cable shall be secured. Label the outlet and each connector as detailed in this specification.
 - b. Provide samples of the following outlet configurations:
 - 1) Wall-mounted
 - 2) Ceiling outlet
 - 3) Floor outlet

F. As-Built Documentation

1. Following completion of the installation, submit the following record drawings, documentation, and testing records for approval.
2. As-Built Drawings

- a. All drawings shall be provided in hard copy (half size) and electronic format in AutoCAD DWG and/or Revit RVT, as directed by the Owner, and PDF files supplied on USB flash drive or other approved media. It is the contractor's responsibility to acquire current architectural backgrounds for production of as-built documentation.
 - b. Legend Sheet: Provide a drawing identifying all symbols used within the as-built record set and any relevant notations.
 - c. Floor Plans: To be of identical scale to architectural document set and consist of all outlet locations, fact plate labels, major cable pathways, riser locations, splice points, consolidation box locations Technology Rooms (TR), Equipment Rooms (ER), and Entrance Facilities (EF).
 - d. Enlarged Plans: Shall be enlarged plans of each TR, ER, EF or Machine room/datacenter. They shall reflect Equipment Racks, Backboards, Telecommunication Grounding Busbars (TGB) locations, equipment rack elevations, wall elevations where equipment is present and cabling pathways.
 - e. Single line diagram as previously submitted and updated to reflect any changes since original submission.
3. Final Test Results
- a. Contractor to provide testing results of all tests performed on each cable indicating tests performed, results obtained, and values measured.
 - b. Test results shall be all inclusive to the scope of work and include punch list items and all required retests for failed components. Incomplete submittals will be rejected without re- view, for re-submittal.
 - c. Electronic native format test results shall include the test equipment manufactures software for reading and interpreting test results. OTDR test results shall be in electronic format as well.
 - d. Test results include the test equipment by name, manufacturer, model number, serial number and copy last calibration certificate.
4. Warranties
- a. 25-year Manufacturer Warranty
 - b. Workmanship Warranty
 - c. Transmittal of non-installed equipment and hardware

PART 2 PRODUCTS

2.1 Not used.

PART 3 EXECUTION

3.1 Not used.

END OF SECTION

SECTION 27 05 03

COMMUNICATIONS THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.01 SECTION INCLUDES

- A. This section includes fire stopping for through-penetrations and joints in or between the following fire-resistance-rated assemblies, including both blank openings, linear openings, and openings containing penetrating items:

1. Floor-ceiling assemblies.
2. Roof-ceiling assemblies.
3. Walls and partitions.
4. Smoke barriers.
5. Construction enclosing compartmentalized areas.

1.02 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.03 REFERENCES

- A. Underwriters Laboratories (UL) of Northbrook, IL "Fire Resistance Directory".
1. Through Penetration Firestop Systems (XHEZ)
 2. Joint Systems (XHBN)
 3. Perimeter Fire Containment Systems (XHDG)
 4. Continuity Head-of-Wall Joint Systems (XHBO)
 5. Fill, Void, or Cavity Materials (XHHW)
 6. Firestop Devices (XHJI)
 7. Forming Materials (XHKU)

8. Wall Opening Protective Materials (CLIV)
- B. All major building codes:
1. International Building Code published by ICC.
 2. (Note to specifier: Retain or delete the building codes listed above as applicable).
- C. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 101: Life Safety Code”.
- D. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 70: National Electrical Code”.
- E. Factory Mutual Approvals (FM) of Norwood, MA “FM 4991: Standard for Approval of Firestop Contractors”.
- F. Underwriters Laboratories (UL) of Northbrook, IL “UL Qualified Firestop Contractor Program”

1.04 PERFORMANCE REQUIREMENTS

- A. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during and after construction.
- B. When intumescent products are used, provide products that do not contain sodium silicate or any other water-soluble intumescent ingredient in the formulation.
- C. Provide firestop products that do not contain ethylene glycol.
- D. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion, and other normal building movements without damage to the seal.
- E. Pipe insulation shall not be removed, cutaway, or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
- F. Fire-rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons, and changes will occur. Such devices shall be:
1. Capable of retrofit around existing cables
 2. Designed such that two or more devices can be ganged together
 3. Maintenance-free such that no action is required to activate the smoke and fire sealing mechanism
- G. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data, and video cabling shall be provided with re-entenable products specifically designed for retrofit.

- H. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movements without damage to the seal.
- I. Provide fire-resistive joint sealants designed to accommodate a specific range of movement and tested for this purpose in accordance with a cyclic movement test criteria as outlined in Standards, ASTM E1966, or ANSI/ UL 2079.
- J. Provide penetration firestop systems, fire-resistive joint systems, or perimeter fire barrier systems subjected to an air leakage test conducted in accordance with Standard, ANSI/ UL1479 for penetrations and ANSI/UL2079 for joint systems with published L-Ratings for ambient and elevated temperatures as evidence of the ability of firestop system to restrict the movement of smoke.
- K. Provide T-Rating Collar Devices tested in accordance with ASTM E814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.
- L. Provide a fire-rated grommet for all individual or small grouped cable applications up to 0.53 in. (14 mm).
- M. Provide moisture-curing products where inclement weather or greater than transient water exposure is expected.

1.05 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 - 1. Review foreseeable methods related to fire stopping work.
 - 2. Tour representative areas where fire stopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.06 WARRANTY

- A. Provide a one-year warranty on parts and labor at a minimum. The contractor should provide an added warranty to the district based on inspection frequency.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A Subject to compliance with through-penetration firestop systems (XHEZ) and/or wall opening protective materials (CLIV) and/or joint systems (XHBN) and/or perimeter fire containment systems (XH DG) and/or continuity head-of-wall joint systems (XHBO) listed in Volume 2 of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
1. Acceptable Manufacturer: Specified Technologies Inc., 210 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.
 2. Hilti, Inc., Tulsa, Oklahoma 800-879-8000 www.us.hilti.com
 3. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.02 THROUGH PENETRATION FIRESTOP SYSTEMS

- A General: LACCD standards should be to provide Kit Style assembly system and putty style fire blocking materials where possible. Use only fire stopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.
- B Intumescent Sealants: Single component intumescent latex formulations containing no water-soluble intumescent ingredients capable of expanding a minimum of 8 times, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSS Intumescent Sealant
 2. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant
 3. HILTI
- C Endothermic Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant
 2. HILTI
- D Elastomeric Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture and accommodate minimum ± 25 percent movement, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
 2. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant
 3. HILTI
- E Firestop Devices: Factory-assembled steel collars lined with intumescent material capable of expanding a minimum 30 times sized to fit the specific outside diameter of penetrating item, the following products are acceptable:

1. Specified Technologies, Inc. (STI) SpecSeal Series SSC Firestop Collars
 2. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars
 3. HILTI
- F. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings, the following products are acceptable:
1. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway
 2. HILTI
- G. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24" (610 mm), the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty Pads
 2. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads
 3. HILTI
- H. Firestop Putty: Intumescent, 100% solids, non-hardening, water-resistant, butyl rubber based putties containing no solvents or silicone compounds, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty
 2. HILTI
- I. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film and capable of expanding a minimum of 30 times, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series RED2 Wrap Strip
 2. Specified Technologies, Inc. (STI) SpecSeal Series BLU2 Wrap Strip
 3. HILTI
- J. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating on all six sides contained in a flame retardant polybag, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSB Firestop Pillows
 2. HILTI
- K. Mortar: Portland cement-based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:

1. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar
 2. HILTI
- L. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or non-sag) or vertical surface (non-sag), the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant
 2. Specified Technologies, Inc. (STI) SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant'
 3. HILTI
- M. All-Weather Coatings: Moisture curing, single-component silicone copolymer elastomeric spray coatings for horizontal surfaces where greater water resistance is required or inclement weather is anticipated, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FT305 Firestop Spray
 2. HILTI
- N. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
1. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam
 2. HILTI
- O. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil capable of sustaining a minimum of 2,500 lbs (1,134 kg) when subjected to load testing, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CS Composite Sheet
 2. HILTI
- P. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CD Cast-In Firestop Device
 2. HILTI
- Q. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FyreFlange Firestop Angles
 2. HILTI
- R. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material capable of expanding minimum of 10 times with expansion beginning at 350°F (177°C) for use in blank openings and cable sleeves, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug
 2. HILTI

- S. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal T-Collar Device
 2. HILTI
- T. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing cable penetrations up to 0.53 in. (14 mm) diameter, the following products are acceptable:
1. Specified Technologies, Inc. (STI) EZ-Firestop Grommet (RFG1 or RFG2)
 2. HILTI
- U. Fire-Rated Closet Flange Gasket: Molded, single-component, intumescent gasket for use beneath a closet flange in floor applications, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series CF34 Closet Flange Firestop Gasket
 2. HILTI

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by fire stopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General Requirements: Install through-penetration firestop systems and fire-resistive joint systems in accordance with the "Performance Criteria" Article and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of fire stopping products.
1. Seal all openings or voids made by penetrations to ensure an air and water-resistant seal.

2. Consult with the mechanical engineer, project manager, and damper manufacturer prior to installation of through-penetration firestop systems that might hamper the performance of fire dampers as it pertains to ductwork.
3. Protect materials from damage on surfaces subjected to traffic.
4. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.
5. Where the joint application is exposed to the elements, the fire-resistive joint sealant must be approved by the manufacturer for use in exterior applications and shall comply with ASTM C-920, "Specification for Elastomeric Joint Sealants".

3.03 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage. The contractor shall be responsible to provide visual inspection at end of the project and shall be responsible to correct any deficiencies prior to the owner's visual verification. Where the owner finds enough repairs are needed, the contractor shall make the repair at no additional cost.
- B. Provide final protection and maintain conditions during and after installation that ensures that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.04 IDENTIFICATION

- A. Provide and install labels adjacent to each fire stopping location. The label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.05 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.

- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for a visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have the sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

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SECTION 27 05 26

COMMUNICATIONS BONDING

PART 1 - GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

- A. Bonding Conductors
- B. Bonding Connectors
- C. Grounding Busbar (TMGB and TGB)
- D. Rack-mount Telecommunications Grounding Busbar

1.2 RELATED WORK

- A. Refer to Division 26 for Raceways and Boxes for Electrical Systems, Grounding, and Bonding for Electrical Systems.
- B. Refer to Division 27 for Basic Communications Systems Requirements, Through Penetration Firestopping, Communication Equipment Rooms, Interior Communications Pathways, and Identification and Administration.

1.3 QUALITY ASSURANCE

- A. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years of documented experience in the manufacture of communications bonding products.
- B. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be Underwriters' Laboratories, Inc. Listed.

1.4 REFERENCES

- A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
- D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 – Customer-Owned Outside Plant

- F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- I. NFPA 70 – National Electrical Code
- J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 96A – Installation Requirements for Lightning Protection Systems
- M. UL 467 – Grounding and Bonding Equipment

1.5 SYSTEM DESCRIPTION

- A. The system described her-in shall meet or exceed LACCD district standards and shall meet at a minimum the work listed below.
- B. Contractor to be responsible for the furnishing, installation, adjusting, and testing of a complete turnkey communication bonding system, including connection to the electrical ground grid.
- C. Performance Statement: The contractor will be responsible to provide proper shop drawings describing the material quality, required features, operational requirements, and performance of the system. The Contractor will be solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- D. The major components of the system shall be as per below per LACCD districtwide standards. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor with minimal or no impact to owner cost.
- E. Basic System Requirements:
 - 1. A complete communications bonding infrastructure is required. Refer to the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
 - 2. The bonding system shall include, but not be limited to, the following major components:
 - a. Bonding Conductor for Telecommunications (BCT)
 - b. Telecommunications Main Grounding Busbar (TMGB)
 - c. Telecommunications Bonding Backbone (TBB)
 - d. Telecommunications Grounding Busbar(s) (TGB)
 - e. Rackmount Telecommunications Grounding Busbar(s)

- f. Bonding Conductor(s) (BC)
 - g. Bonding Connectors
 - h. Bonding system labeling, and administration where required.
3. LACCD Bonding and Grounding Standards:
- a. BDF/IDF rooms shall be provided with a copper Telecommunications ground busbar in each room. The grounding conductor shall be a 1/0 copper wire, cad-welded directly to the Ufer ground, or main entrance ground, or building steel.
 - b. Racks and ladder racks shall be bonded to the Telecommunications ground busbar with a minimum of a # 6 AWG stranded wire.
 - c. The cable tray shall be bonded to the Telecommunications ground busbar in the BDF/IDF rooms on the same floor as the tray. All non-contiguous segments of the cable tray shall bond together using a minimum of a # 6 AWG copper wire, with crimp-on lugs bolted to each segment of the cable tray to ensure electrical continuity throughout the length of the cable tray system.
 - d. Each BDF shall be provided with a copper signal grounding busbar. The grounding conductor shall be 1/0 copper cable, cad-welded directly to the Ground busbar or Main Building Entrance Ground or building Steel.

PART 2 – PRODUCTS

2.1 BONDING CONDUCTORS

- A. Bare Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Minimum size 1-0 AWG.
- B. Insulated Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Insulation:
 - a. PVC insulation with nylon outer jacket.
 - b. Rated \geq 600 volts.
 - c. Green.
 - 3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.
- D. Bonding Conductor Sizing

1. All Communications bonding system conductors shall be sized by length as follows:

Length Linear ft. (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

2.2 BONDING CONNECTORS

- A. Acceptable Types: Mechanical connector bonding lugs shall be prohibited.
 1. Two-hole compression lug
 2. Exothermic weld
 3. Irreversible compression
- B. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING BUSBAR (TMGB AND TGB)

- A. Features:
 1. Busbar to be Wall-mount configuration.
 2. Listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose.
 3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
 4. Busbar shall be provided with stainless steel offset mounting brackets.
- B. Specifications:
 1. Material: Electrolytic tough pitch copper bar with tin plating. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
 2. Hole pattern shall include:

- a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.
- b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

- A. General: each telecommunication rack shall a separate TBB to the TGB as required per district.
 1. Listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose.
 2. Mounts in a standard 19" equipment rack.
- B. Specifications:
 1. Material: Electrolytic tough pitch copper bar with tin plating. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
 2. Hole pattern shall include:
 - a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
 - b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 – EXECUTION

3.1 ADJUSTING

- A. All work must be adjusted and completely secured prior to completion.
- B. The contractor will be required to make all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.
 - A. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General Requirements: Install bonding systems in accordance with "Performance Criteria" and manufacturers installation recommendations with the conditions of testing and classification as specified in the published design.

3.3 TESTING

- A. Test installed system.

- B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.
 - 1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
 - 2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.
 - 3. Under no circumstances shall any point in the communications bonding system has a lower resistance to the ground than that of nearby electrical distribution system components that it is bonded to.
- C. Measure and document voltage between the screen of installed and terminated ScTP, FTP, and/or SSTP horizontal cables and electrical ground of electrical outlet(s) serving the information outlet location area.
 - 1. The voltage between the screen and the ground wire shall not exceed 1.0 V RMS, and 1.0 V dc for any installed and terminated ScTP, FTP, and/or STP horizontal cables.
- D. Include measurement documentation in test data submitted at the completion of the project as required per LACCD district standards.

3.4 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
 - 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
 - 2. The Architect/Engineer shall be presented with the option to attend the training.
 - 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
 - 1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.
- C. Minimum on-site training times shall be:
 - 1. Technical user: Four hours.

3.5 INSPECTION

- A. All bonding systems shall be inspected by the LACCD's representative to ensure proper installation.

END OF SECTION

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SECTION 27 05 28

COMMUNICATIONS RACEWAY

PART 1 - GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

- A. The work covered under this section per LACCD districtwide standards shall consist of the furnishing of all necessary labor, supervision, materials, equipment, tests, and services to install complete wire mesh support systems, conduits, sleeves, inner-duct, etc. for an interior cabling plant. The contractor will be responsible to provide complete shop drawings for approval by the District, EOR, or architect prior to installation and shall comply with the set standards as required. Where contractor installation is provided without approval, said the contractor will be responsible to remove and reinstall any and all equipment or devices to meet district standards at no cost to the owner/district.
- B. The contractor will be responsible to refer to the Latest District Facilities Standards for additional information required to provide proper raceway installation per LACCD's referenced drawings.
- C. Wire mesh support systems are defined to include but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, dropouts, supports, and accessories.

1.2 RELATED WORK

- A. Refer to Division 26 for Conduit, Raceways, and Boxes for Electrical Systems, Grounding, and Bonding for Electrical Systems.
- B. Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be Underwriters' Laboratories, Inc. Listed.

1.4 REFERENCES

- A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces

- D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 – Customer-Owned Outside Plant
- F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- I. NFPA 70 – National Electrical Code
- J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 96A – Installation Requirements for Lightning Protection Systems
- M. UL 467 – Grounding and Bonding Equipment
- N. NEMA VE 2-2000 – Cable Tray Installation Guidelines

1.5 SYSTEM DESCRIPTION

- A. The system described here-in shall meet or exceed LACCD district standards and shall meet at a minimum the work listed below.
- B. Contractor to be responsible for the furnishing, installation, adjusting, and testing of a complete turnkey communication support systems, including bonding connections.
- C. Performance Statement: The contractor will be responsible to provide proper shop drawings describing the material quality, required features, operational requirements, and performance of the system. The Contractor will be solely responsible for determining all components, devices, equipment, connections, and terminations required for a complete and operational system that provides the required performance.
- D. The major components of the system shall be as per LACCD districtwide standards. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor with minimal or no impact to owner cost.

PART 2 – PRODUCTS

2.1 CONDUIT

- A. Refer to Division 26 - Electrical for conduit requirements.

- B. Provide communication cable conduit in locations where access to cable tray is unavailable or where portions of the pathway span are inaccessible (i.e. embedded in walls or inaccessible ceilings). Provide a conduit for small quantities of the cable where cable tray is impractical. Conduit materials may be used to house non-rated cables between endpoints to ensure NEC Code compliance. Conduits serving individual workstation outlets shall be a minimum of 1 inch. The 1-inch conduits shall be connected to 5S deep device boxes (2-7/8-inch deep), equipped with a single gang mud ring at the outlet location. Individual workstation conduits are to be dedicated to only one outlet box each and shall not be “daisy-chained” together.
- C. Acceptable Conduit Manufacturers:
1. Appleton
 2. Crouse-Hinds
 3. Or approved equal
- D. Acceptable Conduit Support Manufacturers
1. Kindorf
 2. Unistrut
 3. Thomas & Betts

2.2 CABLE TRAY

- A. Acceptable Manufacturers:
1. Cable wire mesh systems with solid bottom cable tray systems
 2. Eaton cable tray systems
 3. Nvent Caddy WBT cable tray systems
 4. Approved equal must be accompanied by a comparison chart and will only be taken into consideration. The owner shall provide final approval before installation.
- B. General: Provide wire mesh per LACCD with connector assemblies, clamp assemblies, connector plates, splice plates, and splice bars. Provide drop-out fittings where the cable tray is installed over equipment racks. Two drop-out fittings shall be installed over each rack so that a controlled radius is maintained on each side of every equipment rack that the cable tray passes over. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- C. Wire mesh shall be made of high strength steel wires and formed into a standard 18 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire mesh sides (flanges) shall be rounded during manufacturing for the safety of cables and installers.
- D. Materials and Finishes: Material and finish specifications for each wire mesh type are as follows:

1. Electro-Galvanized Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc per ASTM B633 SC2.
2. Accessories:
 - a. Overhead cable tray shall be provided with bend radius control fittings at all inside corners.

E. Type of Overhead Wire Mesh Support System:

1. All straight section longitudinal wires shall be straight (with no bends).
2. Wire mesh supports shall be trapeze hangers or wall brackets.
3. Trapeze hangers are to be supported by 1/4 inch or 3/8 inch diameter rods.
4. Provide manufacturer-approved grounding clips as necessary for continuous grounding of the tray.

2.3 CABLE HANGERS AND SUPPORTS

A. Provide a non-continuous cable support system suitable for use on a limited basis within concealed accessible ceiling areas (e.g. above removable ceiling tiles) into the outlet locations only.

B. Cable Hooks:

1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
2. All cable hook mounting hardware shall be recessed to prevent damage to the cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use zinc-plated steel, ASTM B633 SC3 suitable for heavy-duty use. Provide stainless steel AISI Type 304 hooks for corrosive locations.

C. Cable Hangers:

1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
2. Steel and woven laminate construction rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
3. Sling length shall be adjustable to a capacity of between 200 and 300 or of UTP, and FTP Cat 6A cables.
4. The cabling hanger load limit shall be 100 lbs per foot.
5. Manufacturer: Erico Caddy, Chatsworth Products, Cooper B-Line, Mono or approved equal.

2.4 PULL BOXES

- A. Acceptable Manufacturers:
 - 1. Hoffman Enclosures.
 - 2. Wire Guard.
 - 3. Approved equal

2.5 METAL OUTLET BOXES – SINGLE GANG FOUR PLEX OR DOUBLE GANG, EXTRA DEEP

- A. Acceptable Manufacturers:
 - 1. RANDL
 - 2. Appleton.
 - 3. Raco.
 - 4. Steel City.

PART 3 – EXECUTION

3.1 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by cable tray, ladder tray, or installed in conduit, such cabling shall be supported by an approved cable hook support system only.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions with a minimum 3/8" rod. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- E. Support spans shall be based on the manufacturer's load ratings. In no case shall a 4-foot span be exceeded.
- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.
- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.2 CONDUIT AND CABLE ROUTING

- A. All conduits shall be reamed and shall be installed with a nylon bushing.
- B. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.
- C. No conduit or sleeve containing more than two (2) cables shall exceed a 40% fill ratio, regardless of length.

- D. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
 - 1. A separate pull box is required for each 90' (or greater) length section.
 - 2. A separate pull box is required after any two (2) consecutive 90-degree bends.
 - 3. The pull box shall be located in an area that maintains accessibility of the box, including the ability to remove the box lid without removal or relocation of any other materials.
- E. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for every 90 degrees of cumulative bend.
- F. Provide conduit in locations where access to cable tray is unavailable or where portions of the pathway spans are inaccessible (i.e. embedded in-wall or inaccessible ceilings).
- G. Provide a conduit for small quantities of cables where a cable tray is not practical.
- H. Minimum conduit size for communications cabling serving individual workstations shall be 1" and be connected to 5s backbox with a minimum depth of 2-7/8" and provide a single gang plaster ring. Individual workstations conduits are to be dedicated to one information outlet location, no daisy-chaining of conduit between backboxes will be accepted.
- I. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense after the conduit condition has been remedied.

3.3 WIRE MESH TRAY STANDARD INSTALLATION REQUIREMENTS

- A. The wire mesh cable tray system shall be only for telecommunications.
- B. Install wire mesh as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- C. Cable tray sections shall be grounded in accordance with the manufacturer's recommendations using manufacturer-approved hardware. Painted sections shall have paint removed at each grounding attachment point.
- D. Test wire meshes support systems to ensure the electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to NFPA 70B, Chapter 18, for testing and test methods.
- E. Provide sufficient space encompassing wire mesh to permit access for installing and maintaining cables.
- F. The tray shall be continuous from source to termination and shall not change elevation, direction, or otherwise expose cables to travel without 2" x 4" mesh support.
- G. Overhead and Underfloor Tray shall be field cut using only manufacturer-approved cutting devices and methods. The cutting device shall be an offset blade bolt cutter; standard bolt cutters are specifically not permitted. Drop-in tray sections shall not be field cut or field modified in any way.
- H. Bends in overhead and underfloor trays shall be accomplished by utilizing the manufacturer's cutting guides.

- I. All splices of tray shall be provided with splice washers, bars, or springs as recommended by the manufacturer.

3.4 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25 lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

- B. Cabling conditions:

1. Horizontal cable length maximum of 90 meters or 295'
2. Tie wraps that distort the cable jacket will affect cable performance
3. Velcro strap shall be utilized to organize cabling
4. 4 pair horizontal cable: 25 lbs. of force maximum pull tension
5. UTP Bend Radius = 4 X Cable OD
6. FTP Bend Radius = 8 X Cable OD

- C. Horizontal Pathways in Conduit

1. Two 90 degree bends maximum between pull points
2. 30 meters (100ft) max
3. Flexible Conduits are not acceptable

- D. Conduit Fill Requirements

1. Maximum 40% fill in conduit
2. Trade Size 1 = 4 CAT 6A UTP Cables
3. Trade Size 1.25 = 7 CAT 6A UTP Cables
4. Trade Size 1.5 = 10 CAT 6A UTP Cables
5. Trade Size 2 = 18 CAT 6A UTP Cables

3.5 INSPECTION

- A. All communications raceway systems shall be inspected by the LACCD's representative to ensure proper installation.

END OF
SECTION

SECTION 27 05 43
COMMUNICATIONS EXTERIOR PATHWAYS

PART 1 - GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

- A. Exterior communication pathway standards below are listed per LACCD and shall be adhered to with minimal disruption to existing facility pathways and underground topology. Contractors shall be responsible to provide and install any underground and exterior conduit and pull boxes without disruption to existing systems throughout the campus where work will be performed.
- B. This section describes the products and execution requirements relating to furnishing and installing telecommunications handholes, exterior pull boxes, cable support ladders, conduits, sleeves, inner-duct, etc. for an exterior cabling plant or parking structures that will require work to be performed.

1.2 RELATED WORK

- A. Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Precast Manufacturer (if applicable): Company specializing in precast concrete structures with three (3) years of documented experience.
- B. The contractor will be responsible for coordinating with other trades, the proper installation of Exterior Trenching, Conduit, Boxes and Manholes, Aerial Entrance Masts, Service Cabinets, Bonding and Grounding, Etc. per LACCD and industry standards and requirements.

1.4 REFERENCES

- A. ANSI/TIA 758-B – Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
- B. ANSI/TIA 607-B - Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises
- C. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- D. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- E. ASTM A48 - Gray Iron Castings.

- F. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.5 SYSTEM DESCRIPTION

- A. The system described here-in shall meet or exceed LACCD district standards and shall meet at a minimum the work listed below.
- B. Contractor to be responsible for the furnishing, installation, adjusting, and testing of a complete turnkey communication exterior pathway infrastructure systems.
- C. Performance Statement: The contractor will be responsible to provide shop drawings for the main pathways must be identified. The Contractor will be solely responsible for determining all components, connections, and terminations required for a complete and operational system.
- D. The major components of the system shall be as per LACCD districtwide standards. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor with minimal or no impact to owner cost.

PART 2 – PRODUCTS

2.1 OUTSIDE PLANT CONDUIT

- A. Rigid Metallic Conduit (RMC) and Fittings:
 - 1. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
 - 2. Fittings and Conduit Bodies:
 - a. End Bell Fittings: Malleable iron, hot-dip galvanized, threaded flare type with provisions for mounting to form.
 - b. Expansion Joints: Malleable iron and hot-dip galvanized providing a minimum of 4 inches of movement. The fitting shall be watertight with an insulating bushing and a bonding jumper.
 - c. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands, and a tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
 - d. Conduit End Bushings: Malleable iron-type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
 - e. All other fittings and conduit bodies shall be of malleable iron construction and hot-dip galvanized.
 - 3. Acceptable Manufacturers:
 - a. Allied, LTV, Steel duct, Wheatland Tube Co, O-Z Gedney, or pre-approved equal.

B. Rigid Non-Metallic Conduit (RNC) and Fittings:

1. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.
2. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.
4. Acceptable Manufacturers:
 - a. Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or pre-approved equal.

C. High-Density Polyethylene (HDPE) Conduit:

1. Minimum Size: 2 inches, unless noted otherwise.
2. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or pre-approved equal.
3. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	< .941
D-1238	Melt Index, g/10 min Condition E	> .55 grams/10 min.
D-638	Tensile Strength at Yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	< 80,000
D-746	Brittleness Temperature	-75°C Max

4. The pipe shall contain no recycled compound except that generated in the manufacturer's plant from the resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
5. Fitting and Conduit Bodies:
 - a. Directional Bore and Plow Type Installation: Electrofusion or universal aluminum threaded couplings. The tensile strength of the coupled pipe must be greater than 2,000 lbs.
 - b. For All Other Types of Installation: Coupler must provide a watertight connection. The tensile strength of the coupled pipe must be greater than 1,000 lbs.

- c. E-loc type couplings are not acceptable in any situation.
 - d. Acceptable Manufacturers: ARCON, Carlon, or approved equal.
 - D. Fittings:
 - 1. Sweeps: Factory manufactured RMC wrapped with 4 mil vinyl tape with a bend radius as follows:
 - a. Conduit internal diameter of 2" or less is 6 times the internal conduit diameter.
 - b. Conduit internal diameter of more than 2" is 10 times the internal conduit diameter.
 - 2. End Caps (Plugs): Pre-manufactured and watertight. The tape is not an acceptable end cap or cover.
- 2.2 HAND HOLES
- A. Type:
 - 1. Polymer concrete
 - B. Dimensions:
 - 1. As indicated in the drawings.
 - C. Requirements:
 - 1. Includes polymer concrete cover cast iron cover steel checker plate covers.
 - D. Acceptable Manufacturers
 - 1. Jensen
 - 2. Old Castle Precast Christy®
 - 3. Brooks.
- 2.3 TEXTILE INNERDUCT
- A. The contractor shall provide and install the Flexible fabric innerduct system in each conduit identified to have copper and fiber optic cable installed.
 - B. Innerduct shall have an 18 gauge solid copper core tracer wire installed into each cell to allow for detection by industry-standard toning equipment.
 - C. Each innerduct cell shall have a pull tape installed.
 - D. Acceptable Manufacturers:
 - 1. MaxCell
- 2.4 UNDERGROUND WARNING TAPE

- A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
- B. Overall Thickness: 5 mils (0.125 mm).
- C. Foil Core Thickness: 0.35 mil (0.00889 mm).
- D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with "CAUTION – BURIED COMMUNICATIONS LINE BELOW". Printing on tape shall be permanent and shall not be damaged by burial operations.
- E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- F. Comply with ANSI Z535.1 through ANSI Z535.5.
- G. Acceptable Manufacturer: CARLON

2.5 UNDERGROUND PULL BOX AND RACEWAY COMPONENTS

- A. Pull Rope 1700lb tensile strength by Carlon.
- B. Bonding ribbon (in Vaults) by INWESCO Cat 12A55.
- C. Bonding ribbon clamps (in Vaults) by INWESCO Cat 12A56.
- D. Fargo Clamp by INWESCO Cat 12A57.
- E. Ground Rod by INWESCO Cat 12A60.
- F. Ground Inserts (Cast Bronze) by INWESCO Cat 12H69.
- G. Manhole and Pull Boxes hardware by INWESCO products.
- H. Manholes by Utility Vault (Oldcastle); Jensen, Brooks.
- I. Manhole lids by Alhambra Foundry, OPW Manhole.
- J. Manhole Ladders by Alhambra Foundry – Model A – 3382 w/A3383 Support Bar.

PART 3 – EXECUTION

3.1 DUCTBANK MINIMUM REQUIREMENTS

- A. Make duct bank installations and penetrations through foundation walls watertight.
- B. Top of duct banks shall be a minimum of 24 inches below grade unless otherwise indicated on drawings.
- C. Assemble duct banks using non-magnetic saddles, spacers, and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.
- D. The transition from non-metallic to galvanized rigid steel conduit where duct banks enter buildings, manholes, and handholes.
- E. Where ducts enter structures such as manholes, handholes, pull boxes, and buildings, terminate the ducts in suitable end bells.

- F. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.
- G. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross-section approximately 1/4 inch less than the inside cross-section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand, or gravel have been left in the duct.
- H. Plug and seal empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

3.2 TEXTILE INNERDUCT

- A. Provide two (2) 3-cell innerducts per 4" conduit or as recommended by the manufacturer.
- B. Install innerduct per manufacturer's guidelines.
- C. Cut and tie off innerduct and pull tape inside each communications vault or Entrance Room.

3.3 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
 - 1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.
- B. Excavation:
 - 1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.
 - 2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill shall be placed in such excess excavations.
 - 3. Excavations shall be protected against frost action and freezing.
 - 4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.
 - 5. Excavation shall be performed in all ground characteristics, including rock if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.
 - 6. In the case where the trench is excavated in the rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
 - 7. Where satisfactory bearing soil is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately and no further work shall be done until further instructions are given.

8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.
- C. Underground Obstructions:
1. The contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.
- D. Fill and Backfilling:
1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.
 2. The Contractor shall provide the necessary sand for backfilling.
 3. Dispose of the excess excavated earth as directed.
 4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris, or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after the installation has been placed.
 5. All trenches shall be backfilled immediately after installation of conduit unless other protection is directed.
 6. All conduits shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.
 7. Use sand for backfill up to grade for all conduits located under building slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
 8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.
 9. Install a warning tape approximately 12 inches below finished grade overall underground duct banks. The identifying warning tape shall be as specified above.
 10. Where the fill and backfilling will ultimately be under a building, floor, or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. The moisture content of the soil at the time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.

3.4 RESTORATION REQUIREMENTS

- A. Where soil and sod have been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching.

END OF
SECTION

SECTION 27 05 53

COMMUNICATIONS IDENTIFICATION AND ADMINISTRATION

PART 1 GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

- A. This section describes the execution and administration requirements set forth by LACCD standards relating to the structured cabling system and its termination components and related subsystems.
- B. Contractor shall Obtain facilities IT Approval for labeling prior to installation. Where Labeling is found to be deficient or not installed per said documents, the contractor will be responsible to reinstall proper labels at no cost to the owner and shall be responsible for time delay where occurs.

1.2 RELATED WORK

- A. Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to other sections for relevant latest standards. See BuildLACCD web site for any additional labeling requirements not listed here-in.
- B. Refer to DW cabling Standards.

PART 2 PRODUCTS

2.1 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement, and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement, and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface, and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
 - 1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quiet zone" of 0.25" on each side of the bar code.

2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.
- E. Color Code: Observe the following requirements for color-coding:
1. Labels on each end of a cable shall be the same color for each termination.
 2. Labels for cross-connects shall be two different colors at each termination field, representative of the color of that field.
 3. Orange (Pantone 15C) shall be used for the demarcation point.
 4. Green (Pantone 353C) shall be used for the termination point of the network connection on the facility side of the demarc.
 5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANs, etc.)
 6. White shall be used to identify the first-level backbone termination in the main cross-connect.
 7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
 8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
 9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
 10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
 11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
- F. Tag all CAT6A and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system. All copper horizontal cables are to be labeled using a machine-printed label at each end of the cable at approximately 4 to 12 inches of the termination point. Handwritten labels shall not be used.
1. (Telecom Room Number) – (Room Number) - (Patch Panel Letter) – (Patch Panel Port Number).
 2. “Telecom Room Number”
 3. “Room Number”
 4. “Patch Panel Letter” shall start with ‘A’ for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
 5. “Patch Panel Port Number” shall start with ‘1’ for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.

6. Example: BDF1001 1023 A 1-2 indicates the first and second modular patch panel port in modular patch panel 'A' in Building Distribution Frame (BDF) 1001 room 1023.
 7. The contractor shall utilize the blank designation inserts which accompany the manufacturer's Patch Panel hardware to label the hardware. The contractor shall remove the Inserts and input LACCD's labeling scheme. All information shall be laser printed, no handwritten labeling shall be permitted or approved.
- G. Tag each individual 900 microns buffered fiber 3" from the connector with a polyester film marker tape as a "flag", designated in a numerical sequence.
- H. Label fiber optic innerduct every 4' with a 1" by 3 1/2" "Fiber Optic Caution" label.
- I. The contractor shall furnish and install self-laminating type labels to the utilized spur cable's overall jacket, six (6) inches from the fiber storage panel strain relief, with the EF/IDF number and fiber number in numerical sequence.
- J. Label the front of each fiber termination shelf with the labels furnished with such shelf, using LACCD's approved scheme.
- K. No handwritten labels will be accepted.

2.2 IDENTIFICATION AND LABELING

- A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.
1. Provide additional cable labeling at each manhole and pull box.
 2. Fiber innerduct labeling shall be provided at both ends using machined-produced labels with Black typeface on Yellow Background, a minimum of 2 inches wide.
 3. Cables that are routed through multiple pathway segments shall contain a reference to all pathway segments in the pathway linkage field.
 4. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color may include blue with a white stripe to indicate the higher performance class station cabling.
- B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.
- C. Termination Hardware Labeling:
1. An identifier shall be provided at each termination hardware location or its label.
 2. The contractor shall label the cross-connect blocks using the appropriate manufacturer's labels. The labels shall be designed every four (4) and/or five (5) pairs as determined by IT. The label designations shall be printed with machine-produced type. Handwritten designations shall not be acceptable. Where handwritten labels are used, the contractor shall be responsible to remove and install proper labeling as required and shall be responsible for time and material.
- D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.
2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

E. Cable Plant labeling:

1. Contractor shall; label splice cases to match the existing labels, using letters with machine-produced black typeface on an Orange Background. The contractor shall identify all binder groups utilizing color Zipp Ties. The contractor shall furnish and install stamped metal band labels on all feed cables indicating cable size, gauge, and plant pair count.

2.3 CABLE TAGS

A. Acceptable Manufacturers:

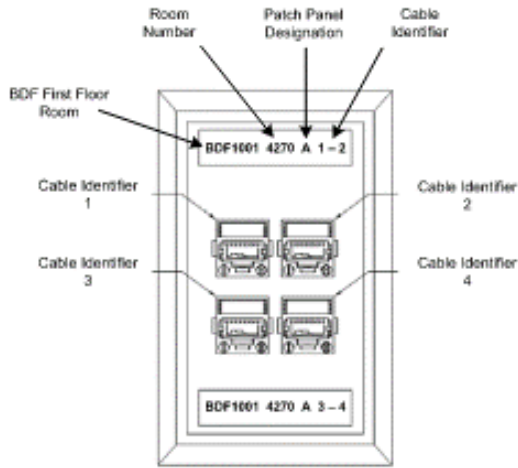
1. 3M
2. Panduit

PART 3 EXECUTION

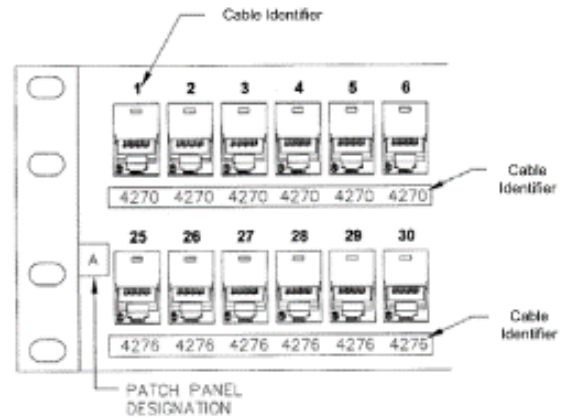
3.1 CABLE LABEL SCHEME PER LACCD

- A. Contractor to present a mockup of a faceplate to facilities IT for verification and approval of the labeling scheme to match campus standards. The following is an example to be followed and approved.
- B. All patch panel ports and telecommunication outlet ports shall be labeled with the cable identifier. Owner may provide specific labeling requirements coordinate with the owner.
- C. All fiber cabling shall be labeled in the front of each fiber termination shelf with the labels furnished with such shelf, using LACCD's approved scheme.
- D. See Attachment A below, Faceplate – Patch Panel – Cable Labeling.
- E. See Attachment B below, Fiber Labeling Layout.
Attachment A

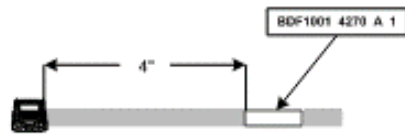
Faceplate – Patch Panel – Cable Labeling



(4) Category 6a Cables/Outlets With 4-Port Faceplate



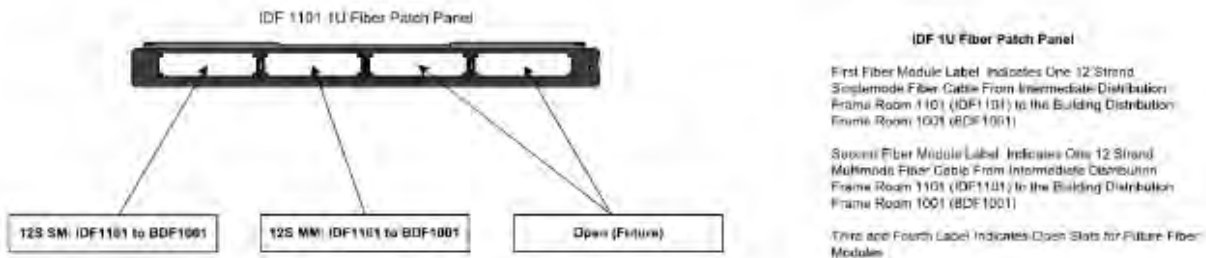
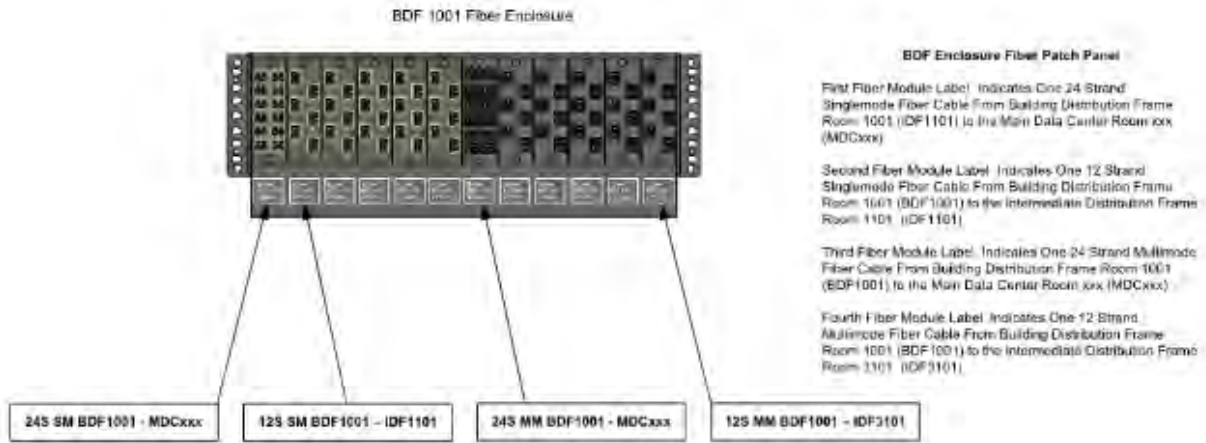
Patch Panel Designations



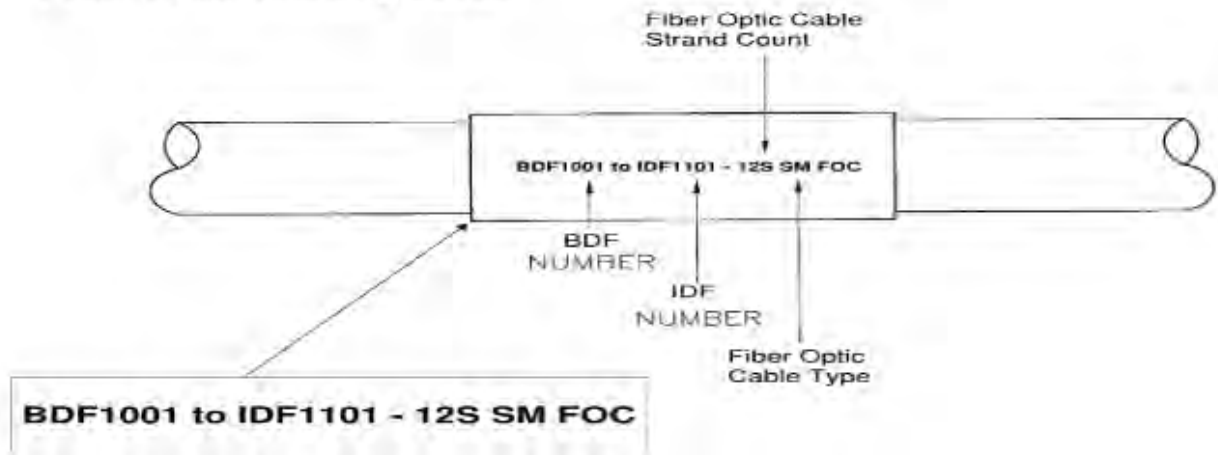
Cable Labeling
Label cable 4" away from each termination with a wrap around machined typed label

Attachment B

Fiber Labeling Layout



Fiber Optic Cabling Label



END OF SECTION

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOMS

PART 1 GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.01 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for Communication Equipment Rooms. Communication Equipment Rooms include rooms for the Building Distribution Frame (BDF) and Intermediate Distribution Frame (IDF).
- B. Definitions:
1. Building Distribution Frame (BDF): Allows single-point administration of technology components for cross-connect of first-level backbone cables, entrance cables, and equipment cables.
 2. Intermediate Distribution Frame (IDF): Cross-connect location between the horizontal cabling and the backbone cabling.
- C. Refer to Specification Section 27 05 28 for cable pathway and support requirements.

1.02 RELATED WORK

- A. Basic Communications Systems Requirements
- B. Communications Bonding
- C. Interior Communication Pathways
- D. Horizontal Cabling Requirements

PART 2 PRODUCTS

2.01 EQUIPMENT GROUNDING

- A. Refer to section 27 05 26 for grounding and bonding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks shall be furnished and installed by the Contractor to house cable termination

components (e.g., copper and optical fiber) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Floor Rack:

- a. Equipment rack shall be 84" in height, self-supporting, and provide a useable mounting height of 44 rack units (RU) (1 RU = 1 $\frac{3}{4}$ ").
- b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
- c. Equipment rack shall be double-side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on the back to accept cable brackets, clamps, power strip(s), etc. The hole pattern on the rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
- d. Equipment racks shall be provided with a supply of spare screws.
- e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.
- f. Provide all mounting hardware and accessories as required for a complete installation.
- g. Manufacturer: Chatsworth Products
 - 4-Post Adjustable Racks
 - Concrete Floor Installation kit

2.3 LADDER RACK

- A. Cabling Contractor to coordinate the installation with Electrical Contractor.
- B. Cabling Contractor to provide and install an 18-inch ladder rack shown on drawings for horizontal cable support.
- C. Include connecting and support hardware to suit installation. Including but not limited to:
 1. Rack-to-runway mount plate
 2. Wall angle support bracket
 3. Butt splice kit
 4. Junction-splice kit
 5. Grounding straps. (Metallic ladder racks must be grounded)
 6. Ladder racking
 7. J-bolt kit
 8. Cable Runway Elevation Kits
 9. Cable Runway Radius Drops
- D. Rack shall be a hollow or solid sidebar nominally 3/8" thick by 1 1/2" high with rungs 12" on center.
- E. Shall be painted black.
- F. Design Make: Chatsworth Products
 1. 18-inch ladder rack

2. Wall angle support kit
3. Wall angle support bracket
4. In-line coupler
5. Junction splice kit
6. Grounding straps
7. J-bolt kit
8. Top plate
9. Cable runway elevation kits
10. Tool-less Pathway dividers
11. Cable runway radius drop, cross members
12. Rack Ground jumper kit
13. Fixed Shelf
14. Foot Kit

2.4 VERTICAL CABLE MANAGEMENT SYSTEM

- A. Vertical wire management is required to manage patch cables within the BDF and IDF Rooms.
- B. Cable Contractor will be responsible for installing wire management and patch cables as part of this specification.
- C. Provide double-sided wire managers and accessories at 4-post racks serving horizontal cabling as indicated on the drawings.
- D. Design Make: Chatsworth Products
 1. 10-inch double-sided vertical wire manager
 2. 6-inch double-sided vertical wire manager

2.5 HORIZONTAL CABLE MANAGEMENT

- A. Horizontal wire management is required to manage patch cables within the Communication Room.
- B. Cable Contractor will be responsible for installing wire management and patch cables as part of this specification.
- C. Provide a 2U wire manager s at 2-post racks serving horizontal cabling as indicated on the drawings.
- D. Design Make: Chatsworth Products
 1. Horizontal Wire Manager

2.6 POWER STRIPS

- A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:
 1. Standard Rack Mount:
 - a. TIA/EIA 19" equipment rack-mountable.
 - b. Compliant with UL-1449 Third Edition and UL-497A.
 - c. Provide transient suppression to 12,000-A. Protection shall be in all three modes (line-neutral, line-ground, and neutral-ground).

- d. Shall meet or exceed ANSI C62 Category A3 requirements.
 - e. Provide high-frequency noise suppression as follows:
 - 1) >20-dB @ 50 kHz
 - 2) >40-dB @ 150 kHz
 - 3) >80-dB @ 1 MHz
 - 4) >30-dB @ 6 to 1000 MHz
 - f. Protection Modes and UL 1449 Clamping Voltage: 475-volt L-N, L-G, and N-G.
 - g. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.
 - h. Be equipped with a 10-foot power cord.
 - i. Design Make: APC or CPI
- 2.7 UPS SHELF
- A. Provide and install a shelf to support rack mount UPS.

PART 3 EXECUTION

3.01 FLOOR MOUNTED RACKS

- A. All Racks shall be anchored to the concrete slab at four points.
- B. Provide vertical and horizontal cable management as described in section 2 and as shown in the drawing.
- C. Mount with a minimum of 36" of clear access if applicable behind and in front of each rack where possible, refer to Telecom enlarged plan drawings.
- D. All racks shall be labeled on top brace utilizing machine-printed labels.
- E. Ground each cabinet to the equipment ground busbar with a #6 gauge. copper wire, "daisy chain" grounding will not be permitted on racks and cabinets. This will prevent ground section break in the case of rack or cabinet removal.

3.02 LADDER RACK

- A. Cabling Contractor to coordinate ladder rack installation with Electrical Contractor.
- B. Ladder Rack is required within the BDF and IDF Rooms.
- C. Ladder Rack to be secured to walls and top of each equipment rack.
- D. Ladder Rack sections must be bonded to each other and the Ladder Rack system shall be bonded to the equipment ground bar with a #6 copper wire.

3.03 CABLE MANAGEMENT

- A. Provide a rack-mounted 2U horizontal cable management system as indicated on the drawings.
- B. Provide two vertical cable managers for each cabinet installed.
- C. The installation of hook and loop "Velcro" fasteners will be the only acceptable form of bundling and securing cables within the BDF and IDF Rooms. Match Velcro color with cable color when possible.

3.04 POWER STRIPS

- A. Cable Contractor shall install one per Rack.
- B. Confirm requirements with Owner prior to purchasing. Should the Owner decide to change the model or type, any return or restocking fees will be the responsibility of the Cable Contractor.
- C. Install per manufacturer's recommendations.

3.05 UPS SHELF

- A. Cable Contractor shall install one per Rack.
- B. Install per manufacturer's recommendations.

3.06 MISCELLANEOUS REQUIREMENTS

- A. All cables shall be neatly "dressed out" in equipment rooms and behind termination hardware.
- B. Fire stops all conduit openings after the cable installation is complete. This includes all conduits with low voltage wire installed.

END OF SECTION

SECTION 27 13 00
COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.01 SECTION INCLUDES

- A. This section describes the products and execution requirements per LACCD relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

1.02 QUALITY ASSURANCE

- A. All cables shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval by the Owner.
- B. Existing pathways (conduit and raceway) shall be reutilized where possible; in all other instances, a new conduit pathway will be provided to support the installation of new Fiber Optic Backbone.
- C. These Specifications and associated drawings are the governing document for the installation of the telecommunications infrastructure and include project descriptions, specified and recommended products, installation and project management methods, the scope of work and elevation drawing specifications.
- D. Any and all materials required to provide a turn-key cabling infrastructure are to be provided and installed by the Cabling Contractor as part of this Scope of Work.
- E. Materials and work specified herein shall comply with the applicable requirements of:
1. ANSI/TIA - 568-C Commercial Building Telecommunications Cabling Standard
 2. ANSI/TIA - 569-A Commercial Building Standard for Telecommunications Pathway and Spaces
 3. TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 4. TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 5. Local Building Code
 6. NFPA 70 – 2002 (current edition), including:
 - a. NEC - Article 770
 - b. NEC - Article 800
 7. Underwriters Laboratory

8. NEMA - 250
 9. Federal Communications Commission 47 CFR 68.
 10. BICSI Telecommunications Distribution Methods Manual (current edition)
 11. BICSI Customer-Owned Outside Plant Design Manual (current edition)
 12. BICSI Information Transport Systems Installation Manual (current edition)
 13. ANSI/NECA/BICSI 568 2001 Standard for Installing Commercial Building Telecommunications Cabling (current edition)
 14. ISO/IEC 11801
- F. The fiber optic cable specified in this project may be used to support a 10 Gigabit Ethernet network. At the time of installation, all fiber optic products shall support the latest draft or formal specification released by the IEEE 802.Z (for 10 Gigabit Ethernet).

1.03 RELATED WORK

- A. Basic Technology Systems Requirements.
- B. Horizontal Cabling Requirements.

1.04 SUBMITTALS

- A. Manufacturers catalog sheets, specifications and installation instructions for all products to be installed within the scope of work and included under this contract (submit with response).
- B. Test Results and Documentation as per Sections requirements.

PART 2 PRODUCTS

- 2.01 Prior to ordering cable, contractor shall physically inspect (field verify) existing and new infrastructure and be responsible for confirming available pathways and needed cable lengths.

2.02 OPTICAL FIBER BACKBONE

- A. Multimode (MM) and Single Mode (SM):
 1. This optical fiber backbone cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.
 2. Optical fiber cable shall be Air-Blown Fiber.
 3. Temperature Range:
 - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
 - b. Operating: -40°C to +70°C.
 4. Humidity Range: 0% to 100%.
 5. Maximum Tensile Strength (≥ 12 fibers):
 - a. During Installation: 1332 Newton (300 lb. force) (no irreversible change in attenuation).

- b. Long-Term: 600 N (135 lb. force).
 6. Maximum Tensile Strength (\leq 6 fibers):
 - a. During Installation: 1000 Newton (225 lb. force) (no irreversible change in attenuation).
 - b. Long-Term: 100 N (67 lb. force).
 7. Bending Radius:
 - a. During Installation: 20 times cable diameter.
 - b. No Load: 10 times cable diameter.
 - B. Optical fiber cables suitable for installation in multiple environments (e.g., underground duct and building risers) may be used at the Contractor's option. Such optical fiber cables shall meet all specifications noted above for cables designated for each environment through which the optical fiber cable shall pass.
 - C. OM4 Multimode:
 1. Sumitomo Electric FutureFlex; FB12G55S
 - D. OS2 Single Mode:
 1. Sumitomo Electric FutureFlex; FB24SX
 2. Sumitomo Electric FutureFlex; FB12SXS
- 2.2 INTER-BUILDING FIBER TUBE CABLE (INDOOR/OUTDOOR)
 - A. Sumitomo Electric Future Flex 4-CELL TUBES; TC04MTX
- 2.3 INTRA-BUILDING FIBER TUBE CABLE (INDOOR PLENUM)
 - A. Sumitomo Electric Future Flex 4-CELL TUBES; TC04TP2
- 2.4 FIBER TUBE DISTRIBUTION UNIT
 - A. Provides tube management and organization
 - B. Sumitomo Electric Future Flex; DE20IDUP
- 2.5 FIBER ENCLOSURE
 - A. Must comply with TIA -568-C standard specifications.
 - B. Rack-mount fiber patch panels shall be mountable in a standard 19-inch rack.
 - C. Fiber optic shall be connected to modular cassettes.
 - D. 2U housings shall be rack mounted.
 - E. Manufacturer: Sumitomo
 1. Fiber panel shelf 2U, part# FT02L06ST
- 2.6 MM FIBER CASSETTE MODULE
 - A. Optical fiber multimode module with LC connectors.
 - B. Manufacturer:
 1. Sumitomo MM cartridge – part# FTLC-FSP12TBFOM4

2.7 SM FIBER CASSETTE MODULE

- A. Optical fiber single-mode module with LC connectors.
- B. Manufacturer:
 - 1. Sumitomo SM cartridge – part# FTLC-FSP24TBFOS2
 - 2. Sumitomo SM cartridge – part# FTLC-FSP12TBFOS2

2.8 COPPER MULTI-PAIR BACKBONE CABLE

- A. Copper cabling shall only be installed for existing campuses where VOIP Systems are not installed. CAT 3 Backbone Cable:
 - 1. The CAT 3 backbone cable shall link Communication Equipment Rooms serving the building. These CAT 3 backbone cables shall be terminated on rack-mounted RJ-45 Category 6A modular patch panels.
 - 2. CAT 3 backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a polyvinyl chloride (PVC) CMR thermoplastic CMP plenum-rated skin. Conductors shall be twisted to form pairs and be full color-coded.
 - 3. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of 10 distinctive colors to identify 25-pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.
 - 4. CAT 3 backbone cable shall meet the TIA/EIA 3 performance requirements.
 - 5. When CAT 3 backbone cables of larger than 25-pairs are required, the core shall be assembled into 25-pair sub-units, each color-coded in accordance with ICEA publication S-80-576-1988. CAT 3 backbone cables with over 600-pair shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained wherever cables are spliced.
 - 6. CAT 3 backbone cables shall contain an overall corrugated, coated aluminum shield that is electrically continuous over its entire length.
 - 7. CAT 3 backbone cables shall be Air Core with an 8-mil ALVYN Sheath.
 - 8. Acceptable Manufacturers:
 - a. General Cable
 - b. Superior Essex
 - 1) OSP 25-pair Part Number 09-097-02
 - 2) ISP 12-pair Part Number 18-872-33

2.9 100-STYLE TERMINATION HARDWARE

- 1. UTP copper backbone cable shall be installed in the ITB building. All copper UTP cable shall be terminated onto plywood backboard wall-mounted 110-style termination hardware. All 110-style blocks are to be permanently labeled as directed by the District Representative.
- 2. All 110 termination hardware shall have C5 Connecting Blocks and wire management installed.

3. Manufacturer:
 - a. Belden, 100-pair with legs, Part Number AX100694
 - b. Belden, 110 Jumper Troughs with legs, Part Number AX100706
 - c. Belden, C5 110 Connecting Blocks, Part Number AX100708
 - d. Belden, 110 Designation Strip, Part Number AX100721
 - e. Or approved equal

2.10 PROTECTION PANELS AND MODULES

1. Inter-building UTP backbone cable protection in building entry rooms at ITB Building and Building 1000.
2. Protection panels shall provide protection for communications equipment and circuits exposed to voltage surges and sneak currents.
3. Protection panels shall be the wall-mount type with 110 input and output connectors.
4. Protector modules shall be UL 497 listed for primary circuit protection and shall provide protection for communications equipment and circuits exposed to voltage surges and sneak currents.
5. The protector modules shall be solid-state, self-resetting, digital and analog, and feature PTC (positive temperature coefficient) technology with 240VDC voltage break over.
6. Manufacturer:
 - a. CIRCA, 25-pair Building Entrance Terminal, Part Number 1880B1-25K
 - b. CIRCA, Surge Protection Modules, Part Number C4B1FS (PTC)

2.11 VOICE FEED CABLE

1. Material – 24 AWG Category 3 25 pair PVC jacketed single-ended cable.
2. Material – 24 AWG Category 3 12 pair PVC jacketed single-ended cable.
3. Length – as needed to reach from the Rack voice patch panel to the Protector Panels installed on the backboard.
4. Length – as needed to reach from the Rack voice patch panel to the 110-block installed on the backboard. Patch panel is 1-pair per port.
5. Acceptable Manufacturers:
 - a. General Cable
 - b. Superior Essex

2.12 COPPER PATCH CABLES

- A. Patch cords:
 1. Provide Category CAT6A specification for UTP copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 2' in length and 40% shall be 3' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
 2. Patch cords shall not be made-up in the field.

3. Manufacturer:
 - a. Panduit P/N: TX6A-28 small diameter patch cables

PART 3 EXECUTION

3.01 FIBER CABLE INSTALLATION REQUIREMENTS

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room or main equipment room, for backbone and intra-building cable.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

3.02 CROSS-CONNECTS

- A. The Contractor will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.
- B. The Contractor shall be responsible for the cross-connect wiring between the horizontal and backbone voice cabling.
- C. The Contractor shall not be responsible for cross-connects between the cabling terminations at the Entrance Room and the telephone utility network point-of-presence. It shall be the responsibility of the Contractor, to work with the Owner and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview, and cable pair identification.

3.03 OPTICAL FIBER TERMINATION HARDWARE

- A. Adhere to all manufacturer installation guidelines.

3.04 OPTICAL FIBER PATCH PANEL

- A. Install as shown on drawings.
- B. Furnish and Install labels for each strand per the Owner's instruction in the field or as shown on drawings.
- C. Install blank adapter panels in all positions not used at time of installation for fiber terminations.

3.05 FIBER GENERAL REQUIREMENTS

- A. All placements shall conform to industry standards with regards to anchoring, cable support, and separation from other facilities.
- B. Cables shall not sag or droop but should be installed to maintain a flat plane with smooth transitions from one level or direction to another.
- C. Fusion splice required, in fiber splice housing enclosures. Only those fiber splices referred to within this document shall be allowed. Splice loss shall be no greater than 0.15 dB. Spliced fibers shall be placed within splice trays. Install trays into the splice housings.
- D. A mechanical splice is not acceptable.
- E. All cables entering and leaving a splice, as well as the splice itself, shall be appropriately racked, routed, and secured to eliminate stress on the cables and/or connections.

3.6 COPPER CABLE INSTALLATION STANDARDS

A. General

- 1. The contractor, prior to placing cable orders, shall inspect existing underground infrastructure and verify that herein specified cables are an appropriate match to existing cables. If cables are not a match, the Contractor shall submit written notice to the Owner and or its agent of the cable disparity and make appropriate recommendations for the correct cable.
- 2. The contractor shall inspect, verify and determine raceway (including required cable) lengths and their adequacy to support specified cable systems, as well as the needed methodology required for installation of cable before proceeding with work.
- 3. The contractor shall ensure that the manufacturer-recommended maximum pulling tensions and minimum bending radius of cables being installed are not exceeded at any time during installation. Failure to follow such guidelines may result in the Contractor providing additional material and labor necessary to rectify any problems resulting from such situations, at no additional cost to the Customer. This shall also apply to any and all damages to cables caused by the Contractor during implementation.
- 4. The contractor shall provide sufficient length for one complete 25' service loop within each communications vault and 25' service loops at each cable end.
- 5. All cables shall be installed with adequate slack to allow for repair and/or splicing as may be required due to damage or breaking.
- 6. All cable, including splice cases, routed vertically or horizontally in maintenance holes shall be secured to existing or, if necessary, contractor-provided manhole racking hardware. Place splice cases at the highest point of the manhole to prevent them from being submerged.
- 7. It is the responsibility of the contractor to keep the work area free of related debris, trash, reels, scrap wire, etc., and to dispose of these materials on a daily basis.

B. Multi-pair Copper Backbone Cable

- 1. All cables shall be installed in a neat and orderly manner that provides the maximum amount of room for future cable additions. Cable shields shall be grounded and bonded end-to-end.
- 2. Cable routes must be field engineered to avoid obstruction of spare ducts and other facilities. Cable routes that block spare ducts shall be re-pulled as directed by the Customer's agent at no additional cost.
- 3. Cables shall be placed with no kinks, twists, or impact damage to the sheath.
- 4. All multi-pair copper cables shall have continuous sheath continuity.
- 5. Each cable shall be identified with a pre-established uniform numbering system. Identification will be securely attached to the cable at each end, whenever it enters or leaves a conduit sleeve, conduit in telecommunication rooms.

6. All cable runs installed in conduit shall include a nylon pull cord (1/4-inch), tied off at each end of run, unless the conduit is full.
7. Placement of cable in individual conduits shall be determined by the Contractor and the Customer's Agent to ensure the most efficient utilization.
8. All cables shall be clearly labeled with cable number, size, at each end of the cable, when it enters or leaves a conduit.
9. All cables shall be routed with wide sweeps without bends or kinks in the cable or sheath. The minimum bending radius for all cable, unless specified otherwise, is sixteen (16) times the cable diameter or manufacturer's specifications, whichever is greater.
10. Cuts and abrasions that penetrate the outer sheath of the cable shall be inspected by the Contractor, Customer, and/or the Customer's Agent to determine if the cable must be replaced or maybe patched. Decisions regarding the suitability of cables damaged during placement will be the responsibility of the Contractor, the Customer, and/or Customer's Agent.
11. All cable shields shall be bonded end-to-end and grounded per TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.

C. VOICE FEED CABLE INSTALLATION

1. Neatly route the cable from the rack location to the Protector Panels. Allow approximately five feet of slack cable at the Rack patch panel.
2. Attach the cable to the cable runway and backboard as necessary. Do not allow the cable to sag.
3. Terminate cable onto the Protector Panels.
4. Provide and install cross-connects between 110 blocks and Rack patch panel for analog voice devices as required.

3.7 TESTING

A. Copper General

1. Testing shall be completed as stated below and prior to final acceptance.
 - a. All test results must be permanently recorded and presented in a format acceptable to the Customer before system acceptance. Any copper pairs failing to meet the above-indicated standards must be removed and replaced (at no cost to the Customer) with cables, which prove to meet the required standards.
 - b. Each test set and associated equipment shall be calibrated per the manufacturers' printed instructions at the beginning of each day's testing and after each battery charge. The test sets shall be fully charged prior to each day's testing.
 - c. The installation will not be accepted until testing has indicated a 100% availability of all UTP cable pairs or the Customer has approved any deviation from this requirement.
 - d. In addition to testing, validation of service at the user end (e.g., computer terminal, telephone, fax, etc.) shall be completed before testing shall be considered complete.

B. Fiber General

1. Testing shall not commence until installation and labeling are approved by the District Representative.
2. The District Representative shall be invited to witness the testing prior to commencing.
3. Every optical fiber in the completed end-to-end shall be 100% tested for defects in installation and to verify performance in accordance with the test specifications defined in ANSI/TIA -568 and TIA TSB-140 Tier 1 and Tier 2.
4. All fibers shall be tested in accordance with this document, the latest ANSI/TIA standards and best industry practice. All fibers must meet the minimum requirement of these standards. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the District Representative for clarification and resolution.

3.8 TEST RESULTS

- A. Fiber cable test results information for each link shall be recorded in the memory of the field testers upon completion of the tests.
- B. The test results records saved by the OLTS Cable Analyzer shall be transferred onto the Test Documentation memory card upon completion of all performance tests. Results data shall be in an unaltered non-printable format and must be compatible with LinkWare Cable Management Software. General information to be provided shall include:
 1. The Contractor name
 2. The Cable ID
 3. The overall Pass/Fail summary of the link under test
 4. The Date and Time the test was performed
 5. Headroom
 6. The Test Limit
 7. The Cable Type
 8. The name of the Technician that performed the testing
 9. The Software Version of the tester software
 10. The model number of the tester
 11. The serial number of the main and remote unit
 12. The identification of the test adapters
 13. The Bi-directional Loss results
 14. Identification of the Site
 15. The Project ID
- C. The test results records saved by the OTDR shall be transferred onto the Test Documentation memory card upon completion. Results, when viewed with the OTDR software tools, shall display:

1. The brand, model, and serial number of the OTDR
 2. The software version of the OTDR
 3. The fiber ID as specified under Installation and Labeling
 4. The signature trace, identifying all splices and connectors
 5. Analysis of the signature trace.
- D. Perform Power Meter Test for each fiber strands. Fluke versive preferred tester.
- E. The test equipment shall be calibrated within 1 year of performing any cabling certification testing.
- F. The test database for the completed job shall be provided to the District Representative on a memory card, including the latest version of any necessary software tools required to view, inspect, and print any selection of the test results. Delivery shall be within three weeks after the completion of the project. The disk shall be clearly identified with the words "Test Documentation, ITB", and the date of completion (month and year) on a machine-printed label.
- G. The test equipment name, manufacturer, model number, serial number, software version, and last calibration date shall be provided as part of the documentation. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation.
- H. When repairs and re-test are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.9 FINAL ACCEPTANCE

- A. Successful completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two-week period will constitute acceptance of the system. The owner will appoint an authorized agent that will sign a formal acceptance document upon completion of all of the above.

3.10 DELIVERABLES

- A. As-built drawing identifying each data port number location on floor plan labeled per district standards for copper and fiber.
- B. Redlines drawing identifying all cable pathways for fiber and copper.
- C. Backbone as-built identifying all splice points, manholes, pull-boxes/transitions, and labeling information on a site plan for copper and fiber.
- D. All copper test results (in Native and PDF format).
- E. All fiber power meter test results (in Native and PDF format).
- F. All fiber OTDR test results (in Native and PDF format).
- G. Tester certification documentation.
- H. Cable records showing copper and fiber cable counts.
- I. Manufacturer 25-year warranty registration for all copper and fiber.

END OF SECTION

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

- A. These standards are provided to serve as a guideline for the construction project to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements per LACCD relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper and optical fiber cabling.
1. Copper Horizontal Cable.
 2. Station Outlets.
 3. Faceplates
 4. Wireless Access Points

1.2 APPLICABLE PUBLICATIONS

- A. Telecommunications Structured Cabling System Standards:
1. The cabling system shall include high-performance copper Category 6A (STP, FTP) cabling where appropriate and as defined by LACCD. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above the ceiling tile, and through plenum air-handling spaces above the ceiling tile. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
 2. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
 - a. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
 - b. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
 - c. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard
 - d. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
 - e. ANSI/TIA-569-C, Telecommunications Pathways and Spaces

- f. ANSI/TIA-598-C, Optical Fiber Cable Color Coding
- g. ANSI/TIA-606-B, Administration Standard for Telecommunications Infrastructure
- h. ANSI/TIA-607-B, Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises
- i. ANSI/TIA-758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
- j. ANSI/TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode fiber Cable Plant
- k. ANSI/TIA -526-14, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
- l. ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centers
- m. ASHRAE 9.9, Thermal Guidelines for Data Processing Environments

PART 2 PRODUCTS

2.1 COPPER HORIZONTAL CABLE (CATEGORY 6A, F/UTP PLENUM)

A. Material

1. Use for voice and data applications to interconnect services from workstation to the wiring closet in a plenum or non-plenum rated space.
2. CMP rated only, except where cabling is routed under-slab on grade, then use OSP rated cable.
3. Four pairs, 23 AWG, Category 6A, F/UTP, as defined by the EIA/TIA standards intended for use with transmission rates up to and including 10 Gbps. Cabling shall be tested up to 750 MHz. Cable shall exceed transmission requirements listed in ANSI/TIA/EIA-568-C.2. Performance tests shall be conducted using swept-frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.
4. The horizontal cable requirements must be met, as well as the following channel requirements.
5. CAT 6A cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
6. Performance tests shall be conducted using swept-frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.
7. Performance data shall be provided by third-party independent testing laboratories only. Testing data shall be submitted on the third-party testing laboratory letterhead. Test data will only be accepted if it displays testing as a channel. Electrical characteristics of the performance of the cable itself will not

satisfy this requirement.

8. The structured cabling and connectivity may be provided by the same company. For this document that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
9. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 500 MHz)	Minimum Margin
Insertion Loss:	3%
NEXT:	2 dB
PS NEXT:	3 dB
PSA NEXT:	3dB
PSA NEXT (Average):	
ACR-F:	2 dB
PS ACR-F:	3 dB
PSA ACR-F:	3 dB
PSA ACR-F (Average):	3 dB
Return Loss:	2 dB

B. Manufacturer:

1. Panduit Cable
 - a. Indoor Plenum Rated (Blue)
 - b. Indoor/Outdoor Rated (Black)
 - c. Outdoor OSP rated (Black)

2.2 OUTLET LABELS

A. Materials:

1. All labels shall be made using a label maker that produces clear adhesive labels with black typeset characters. The labels must have a strong adhesive that will not come off unless it is forced off. The label size will be 3/16 inch wide with a typeset font no smaller than 10 points. The Contractor shall utilize the label maker and labels that are recommended for the selected Structured Cabling System.
2. There shall be no difference, in numbering, between a voice jack and a data jack. Voice and data will be punched down side-by-side on the same patch panel, the campus standard is for all Cat 6A jacks to be identified as D01, D02,

D03, etc. The number indicates the position on the patch panel. So D186 is the 186th position on the patch panel in the telecom room.

3. The Contractor must submit a sample label to the District for approval before labeling the new outlets.
4. Manufacturer: Panduit label or approved equal

2.3 STATION OUTLETS

A. Data Outlets

1. The standard data outlet shall consist of four (4) Category 6A four-pair cables, each terminated on a separate Category 6A rated RJ45 8- position jack following EIA/TIA T568B wiring standards. Jacks colors shall be blue.
2. The modular jacks shall be rated for Category 6A performance in the configuration installed. Manufacturer: Panduit Mini-Com.
3. The faceplate will be clearly labeled with outlet number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate.
4. Dust covers shall be placed in the vacant slots.
5. Manufacturer: Panduit Faceplates

B. Voice Outlets

1. Voice only outlets shall consist of a single four-pair Category 6A cable connected to a wire modular jack assembly with a metal cover plate suitable for securing a wall-mounted telephone. The color of the jack will be white designated for voice.
2. The modular jacks shall be rated for Category 6A performance in the configuration installed. Manufacturer: Panduit Mini-Com.
3. All wall phone outlets shall be placed at 44 inches above the finished floor unless otherwise noted to make the maximum height to the top of the telephone 48 inches above the finished floor.
4. Wall phone outlets shall be equipped with a duplex mud-ring around the standard dual gang outlet box recessed in the wall where possible.
5. Wall phone outlets shall consist of a stainless steel duplex faceplate equipped with a single RJ45 jack.
6. Manufacturer: Panduit Faceplates.

2.4 FACEPLATES

- A. Faceplates will be supplied for every information outlet (voice, data, and network). Unless otherwise noted. They shall meet the required NEMA standard.
- B. All faceplates shall be available in a single, duplex, triplex, quadplex, or six-plex arrangement in a single gang configuration.
- C. Faceplates shall be available in eight plex arrangement in a dual gang box configuration.

- D. Surface mount boxes shall be available in single, dual, quad, and six-plex configuration.
- E. Manufacturer: Panduit Faceplates

2.5 COPPER PATCH PANELS

- A. Modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in modular patch panels consisting of a modular connector system incorporating modular CAT6A jacks.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.
- D. Panel Label: the 48 port patch panels will be terminated from A1, A2, A3, and so on until A40. Ports 41 through 48 will be to be used as spares.
- E. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- F. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturer's minimum bend radius specifications are adhered to.
- G. Manufacturers: Panduit
 - 1. 48-port modular flat patch panel
 - 2. 24-port modular flat patch panel

2.6 COPPER PATCH CABLES

- A. Patch cords:
 - 1. Provide Category CAT6A specification for UTP copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 2' in length and 40% shall be 3' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
 - 2. Patch cords shall be small diameter constructed of 28 AWG with high performance RJ45 modular plugs
 - 3. Patch cords shall not be made-up in the field.
 - 4. Manufacturer:
 - a. Panduit P/N: TX6A-28
 - b. Or approved equivalent

PART 3 EXECUTION

3.1 EXAMINATION

- A Check actual site conditions prior to the start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work that must be checked include, but are not limited to:
1. Electrical requirements (conduit installation and capacity)
 2. The telecommunications rooms are the size shown on the project drawings.
 3. Adequate clearances of doors, riser spaces, and ceilings for all components of the telecommunications system.
 4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 INSTALLATION

- A Process:
1. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA 568C and BICSI, and in quantities indicated in the Telecom Drawings.
 2. Locations requiring horizontal cable shall be, but not limited to Wireless Access points, work area outlet, and camera (indicated in Security Drawings).
 3. Install all cables with proper attention to bend radii, pulling method, attachment method, and pulling forces. All cables shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI installation guidelines. Also, refer to the cable manufacturer's specifications for exact cable requirements per the particular cable type.
 4. All cables shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.
 5. The contractor shall ensure that all TIA/EIA and industry standards are met with special regard to the maximum stripping length of cable jackets. No four (4) pair UTP cables shall have more than three-eighth inch (3/8") of cable jacket removed beyond the termination points.
 6. Install the horizontal cabling with attention paid to aesthetic means and methods when routing cabling within IT spaces. All horizontal cabling shall terminate in their respective floor serving technology space; specifically, cables from floor outlets need to terminate in their corresponding floor telecom room.
 7. All cabling distributed horizontally through metal stud framing shall have plastic protective bushings inserted to protect cables prior to installation.
 8. All cables shall be clearly labeled on both ends and in an accessible location, no more than six inches (0'-6") from the cable ends.
 9. The owner reserves the right to specify a new location for any outlet or equipment without increasing contractor unit cost – providing that the new location is specified prior to roughing-in of technology cable and is no farther than ten (10) feet away from the original location specified.
 10. Communication EMT conduit sleeves shall receive conduit waterfall to control bend radius of the communication cable to a minimum of a 4" radius.
 11. Install all connectors and couplers under the guidelines of the

manufacturers' recommended instructions and per all TIA/EIA 568C standards, BICSI guidelines, and manufacturer-approved industry practices.

12. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade contractor through TIA/EIA 568C testing procedures.
13. Color of all outlet housing components shall be coordinated with the Owner before purchase and installation.
14. All technology outlets located on walls shall be flush mounted, level and plumb.
15. All technology outlets shall be mounted at right angles and parallel to the floor unless installation requirements or design dictate otherwise.
16. Install blank inserts in outlet housing spaces that are not being filled with cable termination modules. Blank inserts shall match the workstation housing color unless otherwise indicated in the drawings.
17. All outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box. If the cable is exposed prior to entering the furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.
18. All outlet housings as well as each individual utilized port must be labeled in accordance with the Owner-approved labeling scheme.

3.3 RE-INSTALLATION

- A. No additional burden to the owner regarding costs, network downtime, and end-user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with the owner prior to beginning any re-installation work.

3.4 CLOSE-OUT ACTIVITIES

- A. The contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Fiber and Copper Cable Systems
 1. The Contractor shall use forms provided by the District or Structured Cabling System manufacturer if approved by the Engineer of Record, to document the successful testing of all inter-building, intra-building, entrance, and tie cables.
 2. Test equipment used shall be Fluke Versive for OTDR and Power meter Testing for fiber and copper cables. Category 6A station cable test results noting unique station numbers and group test results by floor shall be provided. The Contractor shall neatly note floor plans with "as-built" station numbers and any changes, additions, or deletions to outlet placement. Inter-building, entrance, and riser plans shall be updated to include actual routes, cable numbers and counts, and lengths of cables.
- C. Deliverables
 1. As-built drawing identifying each data port number location on floor plan labeled per district standards for copper and fiber.
 2. Redlines drawing identifying all cable pathways for fiber and copper.

3. Backbone as-build identifying all splice points, manholes, pull-boxes/transitions, and labeling information on a site plan for copper and fiber.
4. All copper test results (in Native and PDF format).
5. All fiber power meter test results (in Native and PDF format).
6. All fiber OTDR test results (in Native and PDF format).
7. Tester certification documentation.
8. Cable records showing copper and fiber cable counts.
9. Manufacturer 25-year warranty registration for all copper and fiber.
10. Provide as-built floor plan laminated and placed in each BDF and IDF to show all data drop locations with cable identifiers. Also, to include cable routing for the Backbone Distro site plan with manhole butterfly details "to/from" and all pull points and splice points for copper if applicable.

END OF SECTION

SECTION 27 20 00

DATA COMMUNICATIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Management of Owner who is installing IT Equipment in Telecommunication Spaces before Substantial Completion
 2. Management of third-party providers who are installing equipment to connect to the Owner's network
- B. Related Requirements:
1. Section 01 74 23.05 Final Cleaning of Telecommunication Spaces
 2. Section 14 20 00 Elevators
 3. Section 22 00 00 Plumbing
 4. Section 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)
 5. Section 26 00 00 Electrical
 6. Section 27 05 00 Communications Work Results for Communications
 7. Section 27 00 00 Communications Basic Requirements
 8. Section 27 08 00 Data Communications Commissioning
 9. Section 27 15 00 Structured Cabling
 10. Section 27 13 00 Communications Backbone Cabling
 11. Section 27 41 00 Audio-Video System
 12. Section 28 00 00 Security Systems Basic Requirements

1.2 REFERENCES

- A. Definitions
1. *Owner* Used here to refer to the Owner or the Owner's directly procured contractor
 2. *Third-party provider* is any subcontractor or sub-subcontractor engaged under the Contract to the Contractor providing edge-devices as part of the Work.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
1. Coordinate with third-party providers to understand the LAN requirements of their devices, convey these requirements to the Owner, the network switches cannot be
 2. Liaise with the Owner
 3. Advise third-party providers on how to harden devices
 4. Manage the connection of devices to the network
 5. Manage the owner and the installation of network switches
- B. Preinstallation Meetings
1. Organize and lead a meeting with all third-party providers
 2. Organize a meeting with the Owner to understand their requirements
- C. Sequencing

1. Adhere to Section 27 06 20.10 - Telecommunication Space Room Ready Schedule
2. Determine sequencing of telecommunication spaces in order that the IT Equipment is installed and the third-party providers are able to connect to and make use of the network

D. Notification

1. Notify the Contract Administrator:
 - a. Where the document references sections that are unavailable
 - b. Where conflicts arise from requests in the documentation, implement the most onerous provision

1.4 ACTION SUBMITTALS

- A. Installation schedule for IT Equipment
- B. Sequencing schedule for ensuring third-party providers devices are ready to connect to the network and do connect to the network in time to complete any requisite commissioning

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. Penetration test results including all corrective actions

1.6 QUALITY ASSURANCE

- A. Qualifications
 1. Integrator
 - a. ISO 9001 – Quality Management Certification
 - b. ISO 14001 – Environmental Management Certification
 - c. ISO 27001 – Information Security Management Certification
 - d. Project Manager:
 - 1) Registered Communications Distribution Designer (RCDD)
 - 2) Project management certification:
 - a) Project Management Professional (PMP), or
 - b) Registered Telecommunications Project Manager (RTPM)

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements
 1. Provide physical storage
 - a. Secured with access control and a monitored video security system
 - b. On site
 - c. Sized for Owner's equipment

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 PREPARATION

- A. Ensure all preceding Work is complete.
 - 1. Section 01 00 00
 - 2. Section 27 05 00
 - 3. Section 27 11 00
 - 4. Section 27 13 00
 - 5. Section 27 15 00
 - 6. Section 27 05 53

3.2 MANAGEMENT OF NETWORK INSTALLATION

- A. Manage the Owner and the installation of the network switches and any other IT Equipment in the telecommunication spaces.
- B. Manage the creation of an IT Service Catalog and Configuration Database for every edge-device.
- C. Manage the third-party providers and the connection of their devices to the Owner's network.

3.3 SITE QUALITY CONTROL

- A. Nonconforming Work
 - 1. Review the output of Section 27 08 00 – Data Communications Commissioning. Ensure all third-party providers correct their vulnerabilities.
 - 2. Review the output of the closeout activities: endurance testing and ensure all third-party providers correct all failures.

3.4 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Lead the General Tests
 - 2. Lead the Penetration Test
 - 3. Lead the Cabling Test

END OF SECTION

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SECTION 27 32 43

DAS - PUBLIC SAFETY & EMERGENCY RESPONDER

PART 1 GENERAL

1.01 SUMMARY

- A. Distributed Antenna System (DAS) Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The project delivery of the system will be by the Design-Build method. The Design-Build contractor and/or system vendor shall include all physical infrastructure and pathways to facilitate installation, configuration, and operation of the system. This includes all structural, electrical, mechanical and other infrastructure elements that impact the operation and performance of the DAS and are part of the permanent building structure and finishes. (For example: conduits, pathways, equipment support structures, electrical power services, etc.)
- C. The scope of the DAS will cover the underground parking areas, back of house facilities, and all other accessible areas of levels P1 through P3 in compliance with the California Building Code Section 510 and any other applicable codes and requirements.
- D. The general contractor must coordinate with the City of Beverly Hills Fire department during construction of the building to perform pre-test for expected areas which shall have Public Safety & Emergency Responder coverage within levels P1 through P3. Once the tests have been completed the required areas shall be reviewed by the Design-Build team to confirm coverage by antenna locations remain adequate.

1.02 RELATED DOCUMENTS

- A. General and Supplementary Conditions

1.03 RELATED SECTIONS

- A. Division 01 – General Conditions
- B. Division 07 – Penetration Firestopping
- C. Division 26 - Grounding and Bonding
- D. Division 26 - Raceway and Boxes
- E. Division 26 - Wiring Devices
- F. Division 27 - Communications

1.04 ABBREVIATIONS

- A. ACG: Automatic Gain Control
- B. AHJ: Authority Having Jurisdiction
- C. ATP: Acceptance Test Plan
- D. AWS: Advanced Wireless Service
- E. BDA: Bi-Direction Amplifier

- F. BOM: Bill-of-Material
- G. BTS: Base Transceiver Station
- H. CDMA: Code Division Multiple Access
- I. C/N: Carrier-to-Noise Ratio
- J. CW: Continuous Wave
- K. CWDM: Coarse Wave Division Multiplexing
- L. DAS: Distributed Antenna System
- M. DWDM: Dense Wave Division Multiplexing
- N. ESMR: Enhanced Specialized Mobile Radio
- O. FCC: Federal Communications Commission
- P. GROL: General Radio Operators Licence
- Q. GUI: Graphical User Interface
- R. iDEN: Integrated Enhanced Digital Network
- S. LMR: Land Mobile Radio
- T. LTE: Long Term Evolution
- U. MIMO: Multiple Input, Multiple Output
- V. MTBF: Mean Time Between Failure
- W. NFPA: National Fire Protection Association
- X. NMS: Network Management System
- Y. PCS: Personal Communications System
- Z. PIM: Passive Intermodulation
- AA. PSN: Public Safety Network
- BB. RoF: Radio-over-Fiber
- CC. RoHS: Restriction of Hazardous Substances
- DD. RSL: Received Signal Level
- EE. SISO: Single-Input, Single-Output
- FF. SMR: Specialized Mobile Radio
- GG. SMS: Short Message Service
- HH. SNIR: Signal-to-Noise Interference Ratio
- II. SNMP: Simple Network Management Protocol
- JJ. SOW: Statement of Work
- KK. VSWR: Voltage Standing Wave Ratio
- LL. WSP: Wireless Service Provider

1.5 DEFINITIONS

- A. Acceptance: Expressed approval by the customer
- B. Active: DAS components that require AC/DC power for operation.
- C. Carrier Approval: Expressed approval to interconnect to the WSP macro network.

- D. Channel: A path for an RF transmission between two points.
- E. Component: A main system element of the DAS.
- F. Contractor: The prime contractor bidding the project.
- G. Passive: DAS components that do not require AC/DC power for operation.

1.06 REGULATORY REFERENCES

- A. ANSI/NFPA 70
- B. City of Beverly Hills Building Code.
- C. 2013 California Electrical Code, Title 24, Part 3
- D. 2013 CFC - California Fire Code, Title 24, Part 9
- E. 2013 CFC – California Fire Code, Section 510.
- F. Federal Communications Commission (FCC) - Title 47 of the Code of Federal Regulations, Part 90
- G. Federal Communications Commission (FCC) Rules, Parts 15 and 22
- H. ANSI/IEEE C2 - National Electrical Safety Code (NESC)
- I. NFPA 70-2011 - National Electrical Code (NEC)
- J. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises, published February 2009 and all latest addenda derived from ANSI/TIA 568-B
- K. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, published February 2009 and all latest addenda derived from ANSI/568-B
- L. ANSI/TIA-568-C.2 – Balanced Twisted Pair Telecommunication Cabling and Components Standard, published August 2009 and all latest addenda derived from ANSI/TIA 568-B
- M. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard, published June 2008 and all latest addenda derived from ANSI/TIA 568-B
- N. ANSI/TIA/EIA 569-B - Commercial Building Standard for Telecommunications Pathways and Spaces
- O. ANSI/TIA-606-B – Administration Standard for Telecommunications Infrastructure, published June 2012 including all latest addenda derived from TIA-606-A
- P. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- Q. IEEE 142 “Green Book”- Recommended Practice for Grounding of Industrial and Commercial Power Systems
- R. UL 444 - Standard for Communications Cable
- S. CEC Article 18-27-300.22©(1)
- T. NEC Article 250 for System Grounding
- U. NEC Articles 770 and 800 for Cable Listing Requirements
- V. Work performed should additionally comply with and follow guidelines established in the latest edition/revision, as of the date of the Contract Documents, of the following publications:

1. BICSI Telecommunications Distribution Methods Manual (TDMM)
 2. National Electrical Contractors Association (NECA)/BICSI ANSI/NECA/BICSI-568-2006 Standard for Installing Commercial Building Telecommunications Cabling
- W. All materials shall be new and listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- X. Notify Consultant of all material believed to be inadequate, unsuitable, in violation of law, ordinances, rules or regulations of authorities having jurisdiction.

1.07 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Consultant for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Consultant for a decision before proceeding.

1.08 SUBMITTALS REQUIREMENTS

- A. Submittals shall include complete documentation of the system, products and accessories in a single submittal. Incomplete submittals will be returned unreviewed.
- B. Prior to the start of work the Contractor shall submit shop drawings in an electronic form. Plans shall be fresh designs by the contractor; they cannot be overlays of the Consultant's package which are indicative as the contract documents. Shop drawings shall contain:
1. Full size floor plans showing distribution of antenna conduit and cable routing running within the parking level slab ceilings.
 2. Drawings shall include of donor antenna, routing, equipment, conduits, pullboxes and grounding.
 3. Full size frequency modeling plans and RF Propagation Modeling by iBWAVE Software, or equal subject to review. These shall indicate full coverage expectations of system antennas as per floor plans.
 4. Signal to Noise Interference Ratio (SNIR) Map.
 5. RF Link Budget.
 6. Full size floor plans and elevations of all equipment within telecom room racks and on wall.
 7. Single-line and/or block diagrams indicating signal and component relationships for the system end-to-end.
 8. Equipment wiring diagrams.
 9. Primary and secondary primary sources and connectivity diagram(s).
 10. Physical dimensions of equipment clearly identified.
 11. Bill of Materials.
 12. All seismic bracing and support details shall be provided in coordination with the general contractor as needed.

- C. Permit drawings as required by the AHJ.
- D. Submittals shall include antenna mockups sent to the Consultant for final review. Mockups shall have the manufacturer's cable markings clearly visible.
- E. Where applicable, dimensions should be marked in units to match those specified.
- F. Work shall not proceed without the Consultant's "no exception taken" of the submitted items.
- G. Floor plans will be provided to the Contractor in electronic (AutoCAD, ".dwg") formats to be utilized by the contractor in creating complete submittals and as-built documentation. These modified documents shall be provided to the Owner as part of the Record Documents.
- H. All submittal documentation shall bear the stamp of a currently verifiable BICSI RCDD.
- I. Plans shall be fresh designs by the Contractor; they cannot be overlays of the Consultant's package which is indicative as contract documents.
- J. Contractor must submit documentation to ensure qualifications have been met by the manufacturers. This includes but it's not limited to the following:
 - 1. End to end solution and partner documentation indicating contractor's staff has gone through proper channels and training support the applicable warranty and service program by the manufacturers.
 - 2. BICSI affiliations by contractor.
 - 3. Current copy of the State contractor's license.
 - 4. Documentation of (3) similar projects within the past 5 years in the same State.
- K. Certificates:
 - 1. A FCC-issued general radio operators license (GROL) for the installation personnel.
 - 2. A certificate from the manufacturer of the equipment to be installed stating that the DAS installer is trained and qualified on the equipment.
 - 3. Associated Public Safety Commissions Officials (APCO).
 - 4. National Association of Business Education Radio (NABER).
 - 5. Personal Communications Industry Association (PCIA).
 - 6. Certifications for iBWAVE Software, or equal subject to review.
- L. Test Equipment
 - 1. Submit certificates indicating that staff is certified on required test equipment including by not necessarily limited to:
 - a. Signal Generators.
 - b. Spectrum Analyzers.
 - c. PIM Testers.
 - 2. Submit current calibration data for test equipment to be used.
 - 3. Submit certificates indicating that staff is certified on required test equipment.
 - 4. Submit current calibration data for test equipment to be used.
- M. Equipment cutsheets on any equipment proposed for substitution in compliance with Section 1.7 of the specifications.
- N. Bid Assumptions
 - a. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above with submittal of bid response. Prior to installation, contractors

shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.

- O. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
 - P. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
 - Q. To scale floor plans showing the location of system Components.
 - R. Final RF link budget.
 - S. Detail Drawings for Donor Antenna and grounding.
 - T. RF propagation modeling (Heat maps).
 - U. Product Data Sheets for each type of equipment to be installed.
 - V. Maintenance Service Contract.
- 1.09 SUBMITTAL REQUIREMENTS AT CLOSE OUT
- A. Drawings: Submit as-built drawings indicating:
 - a. Donor antenna, grounding and lightning protection details.
 - b. Cable routing, splitters, couplers and coverage antenna locations.
 - c. Active component locations, layout and configuration.
 - d. All items as listed in Section 1.8 representing final project completed conditions.
 - B. Test Reports:
 - a. PSN: Submit Accepted ATP reports confirming the requirements of Section 1.4 have been met.
 - b. WSP DAS: Submit accepted ATP reports confirming the requirements of Section 1.4 have been met.
 - C. Cable Test Reports: Submit cable test results for all cable segments. Testing shall include Return Loss (RL), Distance to Fault (DTF) and Passive Intermodulation (PIM).
 - D. Field Reports: Submit OTDR test results for all fiber runs.
 - E. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
 - F. Acceptance Certificate or Document from the AHJ
 - G. Warranty Documents:
 - a. Submit for all manufactured components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty
- 1.10 MANUFACTURER CERTIFIED WARRANTY REQUIREMENTS
- A. The system shall be comprised of components from a single manufacturer or a combination of manufacturers entering into a partnering agreement that allows for a warranty of the system.
 - B. System warranty program documents must be from that of the cabling, component and equipment manufacturer and associated partners. Cabling, component and equipment manufacturer warranty programs offered by the contractor alone are not acceptable.

1.11 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- B. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
- C. Requirement for specialists shall not supersede building codes and regulations governing the Work.
- D. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material and design.

1.12 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
- B. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- C. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work.
- D. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1.13 SUBSTITUTIONS

- A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
- B. Contract Documents are based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as, stated or implied in the Contract Documents.
- C. Submit proposals to provide substitute materials or equipment, in writing, in compliance with Bidding and Division 1 requirements. Reimburse Owner for costs associated with the review of the proposed substitution whether substitution is accepted or rejected.
- D. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work of related trades are not permitted.
- E. Proposals for substitutions shall include the following information:
 - 1. Passive Components:

- a. Product samples.
 - b. Detailed product specifications.
 - c. Independent test results verifying the product specifications.
 - d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 7 years from the date of system acceptance.
2. Active Components:
- a. Hardware and software manuals.
 - b. Detailed product specifications.
 - c. Mean Time Between Failure (MTBF) data for each Active Component.
 - d. Independent test results verifying the product specifications.
 - e. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 7 years from the date of system acceptance.
 - f. For Active Components serving the WSPs, written documentation from the WSPs that the alternative component(s) are approved for use within the WSP's network and that interconnection of the DAS to the WSP's network will not be withheld due to the alternative component being used in the DAS.
 - g. For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the DAS to the PSN will not be withheld due to the alternative component being used in the DAS.

1.14 SYSTEM DESCRIPTION

- A. Services: Upon Acceptance Testing, the DAS shall provide coverage for the WSPs and PSNs listed below on all frequencies currently being used by the designated WSPs and PSNs in the given market.
- B. Separate Infrastructures. The PSN DAS shall be deployed on a cabling and antenna infrastructure that is segregated from the components supporting Cellular, paging and facility radio system.
- C. Services Supported. The DAS infrastructure shall be designed to support the services described in Table 1 below.

TABLE 1 SERVICES SUPPORTED ON THE DAS

Baseline Configuration (All information to be determined by BHFD, other local authorities and FCC) Frequencies:	Service Level:	Provider:
453.52500	BH PD 1 Police Dispatch	City/Beverly Hills
453.65000	Police Tactical (Encrypted)	City/Beverly Hills
485.35000	Police Detectives (Encrypted)	City/Beverly Hills
453.22500	Police Traffic Units	City/Beverly Hills
460.6250 N	BHFD Primary Dispatch	City/Beverly Hills

465.5750 N	BHFD Tac/Chain	City/Beverly Hills
453.6875 N	BHFD Tac-Direct	City/Beverly Hills
458.6875 N	BHFD Tac-Direct	City/Beverly Hills

D. PSN Coordination/Approval:

1. The Contractor shall propose and deploy a DAS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).
2. The Contactor shall coordinate and submit all documentation required for AHJ approval.

E. WSP Approval: The Contractor shall propose and deploy a DAS system capable of receiving WSP Approval for interconnection to the WSPs’ macro networks.

F. Broadband Active Distribution: Single-mode fiber-optic cable will be used for active distribution. In-line amplifiers are not allowed.

G. System Management:

1. SMS: The DAS shall have a Systems Management System (SMS) capable of alarm, monitor, configuration and control of all Active Components.
2. SNMP Integration: The DAS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

1.15 PERFORMANCE REQUIREMENTS

A. Public Safety Network (PSN) DAS:

1. The PSN DAS shall comply with CFC 2013 and NFPA-72 as enforced by the local AHJ.
2. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.
3. The DAS shall deliver coverage per the criteria in Table 2 throughout 95% of all occupied building spaces and 99% in critical areas as defined in NFPA 72.

TABLE 2 SYSTEM PARAMETERS PSN

Parameters	Units	Public Safety ~ 450 MHz
Minimum Downlink RSL	dBm	-95

4. The DAS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.

B. Paging and Facility Radio Systems:

1. The DAS shall deliver coverage per the criteria in Table 3 throughout 95% of all occupied building spaces.

TABLE 3 SYSTEM PARAMETERS IN HOUSE SYSTEMS

Parameters	Units	Paging and Facility Radio
Minimum Downlink RSL	dBm	-95

2. The contractor shall explain the method used to avoid downlink and uplink interference.

1.16 OWNER STANDARDS

- A. Wanda Hotel Design Guidelines April 2, 2015.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 1. DAS Simplified.
 2. Zinwave.
 3. Commscope / Andrew.
 4. Or equal subject to review.

2.02 HEAD END COMPONENTS

- A. Public Safety Bi-Directional Amplifier (BDA)
 1. BDA: The BDA shall be of modular design and use digital filtering to mitigate interference and accommodate multiple services for PSN.
 2. Characteristics:
 - a. Operating Temperature Range: -33 °C to +50 °C.
 - b. Chassis: Shall be of modular design with ≥ 4 frequency bands per 19" chassis. Chassis shall not exceed four Rack Units (RUs) in height.
 - c. Filtering: Digital
 - d. Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.
 - e. FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ ESMR frequency bands.
 - f. Alarming: Shall support both SNMP and SMS using wireless modem.
 - g. Mounting Options: Shall support rack, wall and pole mounting.
 3. NEMA 4 or IP65 Enclosure.
 4. Compliance:
 - a. CFC: The BDA shall comply CFC 2013 requirements for supervision and monitoring.
 - b. FCC: Shall be FCC type certified.
- B. System Primary and Backup Power Units:

1. The contractor shall confirm all power requirements (e.g. 120V/20A, 208V/30A) have been met per system requirements. If not, the contractor must coordinate electrical services and connections as needed with the electrical contractor.
 2. Contractor shall design and furnish ability to provide system operation for a period of at least 24 hours when primary power is lost.
- C. Controller and System Annunciation Panel:
1. Provide annunciation panel as necessary per the City of Beverly Hills AHJ. This panel should be located within the Fire Control Room unless otherwise noted.
 2. Provide controller for annunciation panel as/if needed. Controller must be located next to the final location of the annunciation panel.
- D. Fiber-optic Master Unit:
1. When building size dictates an Active fiber DAS, the Fiber-Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.
 2. Characteristics:
 - a. Transmission Media: Single-mode fiber at 1310 nm.
 - b. Operating Temperature Range: +5 °C to +40 °C.
 - c. Impedance: 50 Ohm.
 3. Chassis:
 - a. Shall be of modular design capable of supporting up to 32 Remote Units per 19", 4 RU chassis
 - b. Shall support redundant power supplies
 - c. Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
 4. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
 5. Optical Budget: Shall support ≤ 3 dB optical budget (~3 km or 2 miles)
 6. Auxiliary Channel: Shall provide an input to support 400 to 2700 MHz for future expandability
 7. Interconnect link: Shall support one fiber or two fibers bi-directional optical link for distances up to 20 km with a 10 dB optical budget
 8. Remote Supervision:
 - a. Shall support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers.
 - b. Remote access shall be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems.
 - c. Each Active device shall be manageable via a Web GUI.
 - d. Auto Mapping: Each board position shall be automatically mapped during system turn-up.

2.03 FIBER OPTIC REPEATERS

- A. Public Safety Bi-Directional Amplifier (BDA)
1. The Fiber-Optic Remote Unit converts the RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over the same passive cable and antenna infrastructure.

B. Remote Repeaters for Public Safety DAS

1. Electrical Characteristics:
 - a. Operating Temperature Range: +5 °C to +40 °C.
 - b. Impedence: 50 Ohm.
 - c. Power Consumption: ≤ 105 watts, maximum.
 - d. Output Power per Carrier at Antenna Port:

Technology/Band (MHz)	Carrier (dBm)
~ 450	18

- e. MTBF (excluding external power supply): ≥ 160,000 hours
- f. Frequency Bands supported: 380-520 MHz.
- g. Optical Port: 2xSC-APC connector (separated uplink/downlink)
- h. Antenna Port: Simplex or Duplex 50 Ohm N-type female connectors
- i. Auxiliary Ports: Two SMA female for add-on modules
- j. Uplink Noise Figure:
 - 1) LMR 450 ≤ 16.

2. Enclosure:
 - a. 24"Wx36"Hx6"D.
 - b. NEMA 4 rated, Red for PSN.

2.04 ANTENNAS

A. Public Safety Off Air Antenna

1. Yagi Antenna, or equal. Uplink frequency ranges to meet requirements of DAS system as necessary.
2. Electrical Specifications

Gain	11 dB
VSWR	<1.7 : 1
Horizontal Beamwidth	48 °
Vertical Beamwidth	42 °
Polarization	Vertical
Maximum Input Power	100 Watts
Electrical Downtilt	0 °
Front-back Ratio	>16 dB
Connectors	N-Female
Lightning Protection Direct	Ground

Rated Wind Speed	134 mph / (216 Kph)
Max. Dimensions of Antenna	2.2" x 8" x 33.1" / (55.8 x 203.20 x 840 mm)
Weight of Antenna	1.76 lb. / (0.8 Kg)
Mounting Hardware	U-Bolt

Included Mounting Hardware	fits 1 7/8" OD Pipe
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B. Horizontal Distribution Indoor Antenna

1. Omni-Directional Coverage – shall perform as follows:

Pattern Type:	omnidirectional
Frequency Range:	450-2700 MHz
Gain:	1.9dBd (4dBi) (similar at 2100MHz and 450 MHz)
VSWR:	1.2:1-1.8:1
Polarization:	Multi-Polarized
Impedance:	50 ohms nominal
Diameter:	7.5 in
Height:	7 in
Weight:	1 lb
Connector:	N-Female (others available)
Warranty:	1 Year Limited
Construction:	UV Stabilized ABS
Ground Plane:	Built In
Overall Dimensions	3 in x 3 in x 3 in
Color	White
Pigtail Included	Yes
Pigtail Length	18 in
Application	In Building
Mounting Style	3/4 in stud Mount
Mounting Hardware	Optional L-Bracket
H. Beamwidth (deg.)	360

2.05 COAXIAL CABLING

A. Riser Cabling

1. Construction Materials:
 - a. Jacket Material: Non-Halogenated, fire retardant polyolefin
 - b. Outer conductor material: Corrugate copper
 - c. Dielectric Material: Foam PE
 - d. Flexibility: Standard
 - e. Inner Conductor Material: Copper
 - f. Jacket Color: Black
2. Dimensions
 - a. Nominal Size: (1/2 inch)
3. Electrical Characteristics:

- a. Cable Impedance: 50 ohm \pm 1 ohm
 - b. Capacitance: 22.0pF/ft
 - c. Operating Band: 1 – 5000 MHz
4. Mechanical Specifications:
- a. Fire Retardancy Test Method: UL 1666/ CATVR/ CMR
 - b. Smoke Test Method: IEC 61034
 - c. Toxicity Index Test Method: IEC 60754-1/ -2
- B. Horizontal Distribution Cabling
1. Air Dielectric, Plenum Rated Cable: These cables shall be tested for Return loss, Distance to fault, PIM, continuity, shorts, reversals and grounds where applicable. The results of the tests shall be included in the ATP.
 - a. Material Characteristics:
 - 1) Jacket: Halogenated, Fire-Retardant
 - 2) Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
 - 3) Inner Conductor Material: Copper-Clad Aluminum Wire
 - b. Electrical Characteristics:
 - 1) Impedance: 50 +/- 2 Ohm
 - 2) Frequency Band: 1 - 6000 MHz
 - 3) Peak Power Rating: 40.0 kW
 - c. Mechanical Characteristics:
 - 1) Diameter Over Jacket: \leq .627 in
 - 2) Minimum Bending Radius: \leq 5 in
 - 3) One Time Minimum Bending Radius: \leq 2.5 in
 - 4) Plenum rated
 - d. Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)
 2. Jumper Cables.
 - a. Air Dielectric, Plenum Rated Coaxial Cable, Low PIM, Braided Coaxial cable, off white jacket
 - b. Material Characteristics:
 - 1) Jacket: PVC
 - 2) Braid Material: Tinned Copper
 - 3) Shield Tape Material: Aluminum
 - 4) Dielectric Material: Foam PE
 - 5) Inner conductor: Copper Clad Aluminum wire
 - 6) Jacket color: White
 - c. Dimensions:
 - 1) Nominal Size: 0.355 inch
 - 2) Cable Weight: 0.07 lb/ft
 - d. Electrical Characteristics:
 - 1) Impedance: 50 Ohm
 - 2) Frequency Band: 30 - 6000 MHz

- 3) Return Loss: > 24dB@3GHz
- e. Mechanical Characteristics:
- 1) Bending Moment: 0.5 ft-lb
 - 2) Fire Retardancy Test Method: NFPA 262/CATVP/ CMP
 - 3) Minimum Bending Radius, Single Bends: 1 inches
 - 4) Tensile Strength 120lb
- f. Electrical Performance
- | Frequency | Attenuation (dB/100 ft) |
|-----------|-------------------------|
| 50 MHz | 0.93 |
| 150 MHz | 1.65 |
| 200 MHz | 1.95 |
| 220 MHz | 2.03 |
| 300 MHz | 2.47 |
| 450 MHz | 3.10 |
| 900 MHz | 4.63 |
| 1500 MHz | 6.15 |
| 1800 MHz | 6.82 |
| 1900 MHz | 7.10 |
| 2000 MHz | 7.25 |
| 2500 MHz | 8.25 |
- g. PIM Performance:
- 1) Lower than -152dBc static and -149dBc dynamic PIM with N male connectors on both ends.
- h. Environmental:
- 1) Meet IEC60068 standard.
 - 2) IP65 water resistance level.
 - 3) Outdoor rated with the application of adhesive heat shrink tube to the jumper boot and wrapped with butyl tape.

C. Pre-manufacturing Requirements

1. All cables shall be tested prior to shipment for Return loss, Shorts and PIM

- a. Return Loss:
 - 1) Lower than -20dB during a sweep test.
- b. PIM Performance:
 - 1) Lower than -152dBc static and -149dBc dynamic PIM with N male connectors on both ends.

D. Connectors: N type, male

2.06 SPLITTERS AND DIRECTIONAL COUPLERS

- A. All splitters and couplers will be rated from 50-2700MHz and will be sized with attenuation values required to optimize at the highest required frequency for the system. Type N connectors.

2.07 MISCELLANEOUS

- A. Lightning Arrestor
 - 1. 50-2700MHz general coverage arrestor(s).
 - 2. Flange Mounting.
 - 3. N female to N female.
- B. Grounding Kit
 - 1. Compact Sure grounding kit for donor cable.
- C. Weather Seal Kit
 - 1. Connector weather proof kit.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The contractor shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations.
- B. Locate equipment, antennas and splitters at locations shown on the contract drawings.
- C. Extend cabling from the EOS enclosures to the splitters in a neat and orderly manner per the routing indicated on the contract drawings. Support cabling in compliance with NEC chapter 8 requirements and manufacturers recommendations.
- D. Maintain a 6" minimum distance from the DAS cabling and other cabling for parallel runs. Do not install coaxial cabling open in any areas were the cabling will subject to physical damage.
- E. Install antennas in or above ACT per the mounting details shown in the contract documents.

3.02 EQUIPMENT MOUNTING

- A. Install wall mounted EOS Enclosures in equipment spaces as indicated on plans in accordance with manufacturer's instructions and seismic requirements.
- B. Install EOS Headend equipment rack in equipment space indicated on the drawings. Fasten to the floor per manufacturer's instructions and provide seismic bracing if required in compliance with local codes.
- C. Install donor antennas per details shown on the contract documents.

3.03 COORDINATION WITH OTHER TRADES

- A. Field coordinate the installation of the headend equipment and remotes to ensure that each location is provided with the following:
 - 1. a 120V, 20A circuit served from the life safety generator system for each BDA and remote unit.
 - 2. (2) strands of single mode fiber from the head end location to each remote location terminated in AC APC connectors.
 - 3. Grounding per NEC and TIA standards.
 - 4. Coordinate Alarm and Monitoring points with the Fire Alarm contractor.

3.04 EXAMINATION

- A. The contractor must examine areas and conditions under which DAS components are to be installed and notify the owner's representative, in writing of those conditions which are, in the Contractor's opinion, potentially detrimental to proper completion of the work. The Contractor shall not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the owner.
- B. Examine pathway elements intended for cable, check raceways, cable trays and other elements for compliance with space allocations, installations tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Specific items of examination shall include, but shall not necessarily be limited to, the following:
 - a. Locations for all new DAS antennas, cable and splitter equipment.
 - b. The Contractor shall examine all rooms designated to house DAS equipment to ensure adequate space, power, and environment conditions to support installation.

3.05 TESTING

- A. Acceptance testing will be performed confirming the requirements have been met.
- B. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal. The DAS system shall be tested by a person or persons who are holders of a FCC General Radio Operator's License (GROL) or by the AHJ or his/ her designees.
- C. Testing Procedure (PSN):
 - 1. Test Location
 - a. Each floor of the building shall be divided into a grid of 20 approximately equal test areas.
 - b. Downlink received signal level measurements will be recorded in the coverage area using a CW test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.
 - c. Failure of a maximum of two nonadjacent test areas shall not result in failure of the test.
 - d. In the event that three of the test area fail the test, in order to be more statistically accurate, the floor shall be divided into 40 equal equal test areas. Failure of a maximum of 4our non adjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 90% coverage.
 - e. A test location approximately in the center of each test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.
 - 2. Equipment Requirements
 - a. Test equipment shall be allowed to stabilize in test environment prior to calibration for a minimum of thirty minutes. Any change in temperature can void the calibration.
 - b. Signal generator must be connected to the Head end downlink (TX) interface via tested and approved coaxial cabling and connectors.

- c. Signal generator transmits frequency (MHz) and Power (dBm) must be preapproved by project engineer prior to testing. The control channel from the base station can be used as a signal source as well.
 - d. Verify that all remote units for the area under test are ON.
 - e. Test frequency and power must be recorded corresponding to the date and time of each site walk measurement.
 - f. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be preapproved by the project engineer.
 - g. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center/measured frequency.
3. Documentation
 - a. Exact location of measurement must be marked on the grid print.
 - b. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid##"A", Grid## "B" etc.
 - c. Results of testing are reported to project engineer for analysis and reporting.
- D. Proof of Performance and Testing Methodology
1. Test requirements specified in this document shall be successfully completed prior to issuance of a Certificate of Occupancy and yearly thereafter. Also testing with a successful result shall occur whenever a design change is made to the system, which changes the technical performance or coverage of the system. All tests shall be coordinated 10 days in advance with the AHJ. Results of the test shall be reported in writing to the AHJ.
 2. Equipment Requirements
 - a. Test equipment shall be allowed to stabilize in test environment prior to calibration for a minimum of thirty minutes. Any change in temperature can void the calibration.
 - b. Signal generator must be connected to the Head end downlink (TX) interface via tested and approved coaxial cabling and connectors.
 - c. Signal generator transmits frequency (MHz) and Power (dBm) must be preapproved by project engineer prior to testing
 - d. Verify that all remote units for the area under test are ON.
 - e. Test frequency and power must be recorded corresponding to the date and time of each site walk measurement.
 - f. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be preapproved by the project engineer.
 - g. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center/measured frequency.
 3. Documentation
 - a. Exact location of measurement must be marked on the grid print.
 - b. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid##"A", Grid## "B" etc.
 - c. Results of testing are reported to project engineer for analysis and reporting.

- d. Test Data shall be tabulated and reported to demonstrate that the system meets the specified coverage of -70dBm over 95% of the floor Area.

E. Technical Training.

1. The Contractor shall be responsible for organizing a structured demonstration of acceptance tests to ensure organized and efficient testing.
2. The Contractor shall provide written notice to the owner's representative at least thirty (30) calendar days in advance of the initiation of final system acceptance testing. Included in the advance notice shall be three (3) copies of the approved test plans and procedures to ensure acceptance test monitoring personnel are familiar with the tests, procedures and the expected results.
3. It is the responsibility of the Contractor to notify the owner's representative at appropriate times to permit visual inspections of all DAS components. No Installation work shall be covered until a visual inspection has been completed.
4. Provide the owner's representative with the opportunity to witness all testing. On reasonable request and with ten (10) working days' notice, the Contractor shall demonstrate that the test procedure competently identifies the parameter being demonstrated or the fault condition being tested.
5. The Contractor shall provide a Certificate of Compliance signed by a responsible company representative after completion of the site installation. This document shall certify that each element of the installed system and wiring complies with the requirements of the Contract Documents and the certification shall be included with the final acceptance report.
6. The Contractor shall provide training for elements of the DAS. Such training shall include management, operational and maintenance levels and shall be provided to individuals (maximum of 3) to be designated by the owner's representative.
7. Training shall be conducted by qualified personnel fully conversant on the equipment, materials, software, and over all operation of the installed elements. Training shall be based upon as much hands-on training as is possible. The Contractor shall provide all necessary training aids and materials, which shall include written handouts.
8. All training shall be completed prior to Final Acceptance.

3.06 TRAINING

- A. Retain the Systems Integrator to instruct the Owner/ Owners Maintenance Personnel on the proper operation of the system including alarms.
 1. Provide time for 1 training session for three hours.
- B. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

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SECTION 27 41 00

AUDIO VISUAL SYSTEMS

PART 1 GENERAL

1.01 CORRELATED DOCUMENTS AND OTHER WORKS OF JURISDICTION

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Architectural Drawing Package, and any current revisions noted by project management.
- C. Audiovisual (AV) systems drawings and other attached appendices and tables.

1.02 DEFINITIONS OF TERMS

- A. Owner: shall refer to LACCD, and all subsidiaries and affiliates
- B. Architect: shall refer to the designated project architect
- C. Audiovisual Consultant (Audiovisual Consultant, Consultant): shall refer to Vantage Technology Consulting Group. Refer to "PART 1, SUBMITTALS" for any specific identification.
- D. Project/Construction Manager (CM): shall refer to BuildLACCD
- E. General Contractor (GC): shall refer to the GC awarded the construction contract.
- F. Bidder: shall refer to any party proposing to provide the services and material delineated in this Specification.
- G. Bid: shall refer to a Bidder's proposal to provide the services and material delineated in this Specification.
- H. Audiovisual Integrator (Audiovisual Contractor, Integrator, Contractor): shall refer to the awarded contractor for this scope of services.
- I. Audiovisual Specification (Specification): shall refer to the complete set of designs, performance, and delivery requirements delineated within this document and all referenced documents.
- J. Audiovisual System (AV System): shall refer to the complete complement of equipment, software, and other material that upon completion of assembly, installation and configuration provides the full functionality and technical performance delineated in this Specification.
- K. Audiovisual Equipment (AV Equipment): shall refer to any and all individual equipment items and equipment items supplied by others installed as a part of the Audiovisual System.
- L. Work: Design and provision the Audiovisual Systems and associated equipment, software, and services for the Project.
- M. Construction Documents: shall include all documentation associated with the design and general construction of the Project, including this Specification.
- N. Provide: Supply (furnish), deliver, install, test, configure, label, and commission.
- O. Manufacturer: shall refer to the original manufacturer of any equipment provided as part of the Work
- P. Commissioning Date: shall refer to the date at which a system is formally accepted by the Owner.
- Q. OFE: Owner Furnished Equipment.
- R. OFCI: Owner Furnished, Contractor Installed.
- S. CFCl: Contractor Furnished, Contractor Installed.

1.03 SCOPE/DESCRIPTION OF WORK

- A. The work covered in this specification consists of furnishing all labor, material, and services to install a complete audiovisual system as indicated on the project documentation, including this specification and related drawings.
- B. The work described in this Specification shall include, but not be limited to, the following Basic Services:
 1. Engineering and Design: The Audiovisual Systems Integrator shall provide all system engineering and design necessary to develop the complete systems described herein. Engineering and Design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules, and lists.
 2. Procurement and Assembly: The Audiovisual Systems Integrator shall procure and assemble all hardware and equipment and any additional materials as required to deliver completely functioning Audiovisual Systems, unless otherwise noted.
 3. Software Programming: The Audiovisual Systems Integrator shall perform all required software setup, configuration, and programming required to develop a complete operating system in accordance with this Specification, including all control logic and push-button component faceplate or interface programming.
 4. Installation: The Audiovisual Systems Integrator shall install all equipment, cable, wiring, connectors, plates, and other material at the Project site per the Audiovisual Systems Integrator's approved designs. The Audiovisual Systems Integrator shall install any Owner Furnished Equipment identified in this document and calibrate it to work with the integrated systems.
 5. Testing and Adjustment: The Audiovisual Systems Integrator shall perform all tests and adjustments, furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this Specification and the Audiovisual Systems Integrator's approved engineered designs.
 6. Acceptance Testing: Prior to Owner acceptance and hand-over of the completed Audiovisual Systems, the Audiovisual Systems Integrator shall demonstrate the operation of the complete systems, including all individual devices and specified control functions. Both subjective and objective tests may be required by the Owner to determine compliance with the information in this Specification and the Audiovisual Systems Integrator's approved designs.
 7. Training: The Audiovisual Systems Integrator shall provide technical training of the Owner's staff, instructing them on Audiovisual Systems operation, maintenance, and troubleshooting.
 8. Warranty: The Audiovisual Systems Integrator shall warranty the Audiovisual Systems in accordance with the terms of this Specification.
 9. Specific Responsibilities:
 - a. Supply and install miscellaneous material, as necessary, to mount the audiovisual system equipment.
 - b. All primary conduit and wire-ways are included in the General Contractor's scope of work and are not to be provided in the Audiovisual Systems Contract. Supply and install all miscellaneous conduit and wireways to the extent not included in Division 26 in order to provide a complete and operable system.

10. The Preliminary Schedule below identifies critical Project milestones and delivery expectations currently anticipated. This information is provided for Bidder planning purposes only. The actual Schedule for delivery of the work shall be coordinated with the Owner's representative or Construction Manager.
11. Refer to "BID SUBMITTALS", Section 1.06 and "SUBMITTALS", Section 1.09 for additional information and requirements.
12. Green Building Requirements: Refer to the following Division 1 sections for general Green building requirements. Additional requirements are described in "SUBMITTALS", Section 1.09P and "SUSTAINABLE BUILDING CRITERIA", Section 1.10.
 - a. Construction Waste Management (017405)
 - b. Interior Air Quality Management (017410)
 - c. Sustainable Design and Construction (Includes Green Building Materials Certification Form) (018113)
 - d. Limits for Volatile Organic Compound Contents for Adhesives, Sealants, Paints and Coatings (018115)

1.04 REGULATORY REQUIREMENTS

- A. All onsite labor must comply with job-site union requirements.
- B. The Audiovisual Systems Integrator must obtain any permits and shall pay all fees required by public agencies having jurisdiction over the Work.
- C. All products and materials provided shall be listed by Underwriters Laboratory (UL) and shall bear the UL label intended for the purpose specified and indicated. If UL has no published standards for a particular item, then other national independent testing standards shall apply, and such items shall bear those labels.
- D. All equipment and installations under this Specification shall conform to the latest editions of the following:
 1. NFPA 70 - National Electrical Code.
 2. NFPA 72 - National Fire Alarm and Signaling Code
 3. IEEE C2 - National Electrical Safety Code
 4. ANSI/TIA-568, -569 and -607 Telecommunications Standards
 5. IEEE 142-2007 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- E. The Audiovisual Systems Integrator and its employees shall perform all work in compliance with current Occupational Safety and Health Administration (OSHA) guidelines and regulations and other safety and health requirements as may be mandated by the Owner, the General Contractor, or other authorities.
- F. The Audiovisual Systems Integrator shall have a thorough knowledge of governing codes and standards in effect and having jurisdiction over the Project. Lack of awareness of any of the relevant codes and standards will not be accepted as a reason for non-compliance.
- G. The Audiovisual Systems Integrator shall be responsible for providing cable and materials that comply with applicable codes and requirements of regulating bodies. The cost for these materials shall be included in the Bid price, as the Owner shall not accept change orders for changes in materials.

1.05 COORDINATION OF RELATED WORK BY OTHERS

- A. Related Work Specified Elsewhere: The Audiovisual Systems Integrator shall coordinate with the General Contractor and other construction trades to ensure proper integration and operation of the Audiovisual Systems with the complete Project designs, building systems and all other elements of the Project. The Audiovisual Systems Integrator should request from the Owner, General Contractor, or Architect complete project Construction Documents to help facilitate effective coordination of the Audiovisual Systems Integrator's work with the work of others.
- B. Some components of the complete Audiovisual Systems will be provided by the GC, its sub-contractors, or the owner. It shall be the responsibility of the Audiovisual Integrator to coordinate with all parties whose work impacts the Audiovisual Integrator's work to ensure the complete coordination and successful implementation of the Audiovisual Systems. Related work by GC shall include, but may not be limited to, the following:
1. Electrical Work (Division 26):
 - a. Electrical (AC) Power Service and Connections:
 - 1) Technical Power Service: All electrical panels, power receptacles, lighting fixtures, dimmers, lighting controls, and interconnecting wiring shall be supplied by the Electrical Contractor.
 - 2) The Audiovisual Integrator shall extend AC power circuits and insulated ground wires into each equipment rack. This work must be done by a qualified electrician, licensed in the jurisdiction of this project, and under direction from the Audiovisual Integrator.
 - b. Low Voltage Cable Containment
 - 1) Low voltage cable containment, including raceways, conduits and junction boxes, required to support Audiovisual System devices and interconnecting cabling shall be as specified in the Construction Documents and shall be provided by the Division 26 Contractor.
 - 2) Upon commencement of work on the Project, the Audiovisual Systems Integrator shall review the Construction Documents to confirm that the infrastructure provided is sufficient to accommodate the Audiovisual Systems to be installed. Any conflicts or issues must immediately be brought to the attention of the Construction Manager or General Contractor, and the Audiovisual Systems Consultant.
 - 3) The Audiovisual Integrator shall provide blank cover plates or panels for all floor, wall, and ceiling boxes that are dedicated to the Audiovisual Systems but do not have devices and/or connectors at the time of Audiovisual System commissioning. Colors and types shall be coordinated with the Architect. Devices and plates for other trades (AC power, voice/data, and security) within the AV floor boxes are by those respective contractors.
 2. Metals (Division 5)
 3. Rough Carpentry (061000)
 4. Millwork (062200) and Interior Architectural Woodwork (064023): All millwork and cabinetry modifications required to accommodate the installation of Audiovisual Systems, equipment, and related cabling and connections, except as may be individually identified in this Specification, shall be provided by General Contractor.
 5. Joint Sealants (079200)
 6. Glazing (088115)
 7. Finishes (Division 9)
 8. Projection Screens (115213)

9. Information Technology Systems: Unless otherwise specified, all data networking cabling shall be provided by the Section 271300 and 271500 contractor(s) and the Owner. Unless otherwise specified, all active data networking electronics shall be provided by the Section 272000 contractor and the Owner. Patch cords to connect audiovisual equipment to a data network port shall be provided by the Audiovisual Systems Integrator. The Audiovisual Systems Integrator shall be responsible for coordinating with the Owner or the Owner's designated representative regarding connections between the Audiovisual Systems and the Owner's data network, including all client/server computing and peripherals, Internet, digital video storage and other data/media distribution systems.
10. Paging and life safety: Interfacing the Audiovisual System(s) to the paging or life safety systems may be required. The Audiovisual Integrator shall be responsible for coordinating with the Contractor or the Owner's designated representative regarding connections between the Audiovisual Systems and the Paging or Life Safety system. All Audiovisual Systems with a control processor shall be connected to the fire/life safety systems by cabling extended by the F/LS contractor into the AV equipment rack and shall be configured upon fire alarm or testing contact closure trigger to mute the audio until the trigger is cleared and the system audio (program and voice) can be un-muted again.
11. Audiovisual System Connections to Building Systems and Controls:
 - a. Building systems and controls provided by the General Contractor or Owner that may be interconnected to the Audiovisual System shall include environmental controls, fire and life safety, and security systems. Where required, interconnection between these systems and the Audiovisual System is designated in these Specifications and in the Construction Documents, including requirements for low voltage interface electronics. The Audiovisual Systems Integrator shall verify that all required system components and interfaces are specified and provided to enable the functional performance described in this Specification.
 - b. The Audiovisual Systems Integrator shall coordinate with the General Contractor to verify that all devices and controls to be interconnected to the Audiovisual System are functioning properly prior to commencing interconnection to the Audiovisual Equipment.
 - c. The Audiovisual Systems Integrator shall investigate all hardware and software control conflicts between the building systems and the Audiovisual Equipment before interconnecting the building systems. Report any conflicts, potential or existing, to the Audiovisual Systems Consultant, in writing, before interconnecting the systems. Damage caused to any base building systems due to the improper connection of Audiovisual Equipment shall be the sole responsibility of the Audiovisual Systems Integrator.
 - d. The Audiovisual Systems Integrator shall select and install the appropriate cable type to facilitate device communication from the Audiovisual Equipment to interconnected building systems.
 - e. The Audiovisual Systems Integrator shall coordinate with the General Contractor to verify proper operation of the connected Audiovisual Equipment and the building systems after interconnecting the systems.

12. Other Systems: The Audiovisual Systems Integrator shall be responsible for identifying and integrating with any other technology systems and services required to deliver the completely operating Audiovisual Systems.
 13. Equipment Mounting and Support:
 - a. Structural support for audiovisual system equipment shall be provided by others as noted and detailed in the Construction Documents. The Audiovisual Systems Integrator shall coordinate with the General Contractor and other trades as necessary to ensure compatibility of the structural supports provided by others with the Audiovisual Equipment provided by the Audiovisual Systems Integrator.
 - b. The Audiovisual Systems Integrator shall install all Audiovisual Equipment, including all loudspeaker and video monitor mounts, as indicated in this Specification and the Construction Documents. The Audiovisual Systems Integrator shall verify location and structural suitability before attaching equipment and mounts. Any variations from the drawings and specifications or any question of structural integrity shall be brought to the attention of the General Contractor, Architect, and Audiovisual Systems Consultant before installing the equipment.
- C. Work Furnished by Others ("F.B.O.") but installed by the AV Contractor:
1. Owner Furnished Equipment (OFE): Some equipment that will become a part of or connect to the Audiovisual Systems may be provided by the Owner and shall be designated as Owner Furnished Equipment (OFE). Owner Furnished Equipment shall be supplied by the Owner to the Audiovisual Systems Integrator for connection, installation and/or integration into the Audiovisual Systems as delineated in the construction documents and this Specification. This may include new or existing equipment. The Audiovisual Systems Integrator shall be responsible for coordinating with the Owner's representative or Construction Manager to ensure that all Owner Furnished Equipment is fully operational and compatible with other Audiovisual Equipment and that it is made available to the Audiovisual Systems Integrator in a timeframe that does not delay the Audiovisual Systems Integrator's work.

1.06 BID SUBMITTALS

- A. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors are not compensated for conditions that can be determined by examining documents or site and will not be relieved of any obligations with respect to bid.
- B. Questions: Submit all questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to all bidders as addenda and will become part of the Contract. The Architect and Owner may give, but will not be responsible for, oral clarifications. Questions received less than 10 days before bid date cannot be answered in writing.
- C. Equipment Availability: Verify with manufacturers' availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- D. Performance Bond (Add Alternate): Furnish a Performance Payment Bond and Labor and Material Bond, underwritten by a surety company approved by the Owner or Owner's representative, for fulfillment of all provisions of the contract.
- E. Basis of Bids: To be eligible for Bid consideration, submit bids in accordance with the following:

1. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for all specified items. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
2. Clearly indicate the total cost, including all expenses, for each individual system to allow the Owner to select any or all to be included in the contract. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
 - a. Building or room type:
 - 1) General Classrooms; cost each and total
 - a) Classroom 308
 - b) Classroom 209
 - 2) Computer Lab; cost each and total
 - a) Computer Lab 206
 - b) Computer Lab 2
 - 3) Tutoring / Technology and Testing; cost total
 - 4) Tutoring Center 110; cost total
 - 5) Dietetics Lab and Suite; cost total
 - 6) Orientation Room 203; cost total
 - 7) Interview Room 406; cost total
 - 8) Employee Lounge & Break Room; cost total
 - 9) Multipurpose Room (Divisible); cost total
 - 10) Conference Rooms; cost each and total
 - a) Presidents meeting room
 - b) Large Meeting Room 309
 - c) Meeting Room 301
 - d) Meeting Room 1
 - e) Meeting Room 2
 - f) Meeting Room 18.7
 - 11) Small Meeting Rooms; cost each and total
 - a) President and Vice President's Offices
 - b) Staff Development Work Rooms
 - c) Small Meeting Room
 - d) X-Small Meeting Room
 - b. Building-wide system
 - 1) Digital Signage; cost each and total
3. Organize each list with the information presented, in the order that it appears in this specification, in 6 columns from left to right:
 - a. Paragraph number as it appears in this specification.
 - b. Paragraph title as it appears in this specification.
 - c. Manufacturer and model number.
 - d. Quantity.
 - e. Unit Cost.
 - f. Extension (unit cost times quantity).
4. At the end of each list, indicate the cost of all other items such as for miscellaneous equipment, engineering, installation labor, overhead, taxes, etc.
5. On a separate list, indicate costs of any specified add- or deduct-alternates with the information presented in the same manner as for the base-bid system.

6. Include a listing of any voluntary alternates proposed by the bidder as substitutions or additions to the specified systems.
 7. Include any notes or comments, if necessary, to qualify the bid.
 8. Identify any sub-contractors and indicate the work that is in their scope.
 9. Provide documentation of ability in installing similar systems. Furnish the names, addresses and telephone numbers of the System Designer, Architect, General Contractor and Owner on three projects similar in scope, which the Contractor has installed within the last 5 years.
 10. Identify the proposed project management, engineering, and installation staff. Include resumes for each individual indicating relevant experience and certifications.
 11. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required, and the date of last calibration traceable to NIST, as applicable.
 - a. GENERAL CONTRACTING
 - 1) Multimeter.
 - 2) Cable Tester (Kopul CBT-MF or similar).
 - b. VIDEO/BROADCAST/TELECONFERENCE
 - 1) Multi-frequency computer test pattern generator with DVI output.
 - 2) Photometer with luminance and illuminance probes.
 - 3) DVD format test disc: 3:4 (SMPTE 259M-C) and 16:9 (SMPTE 294M/296M) NTSC/ATSC/US region 1 material.
 - 4) Fiber-optic testing and field servicing equipment.
 - c. AUDIO
 - 1) Measurement Microphone; 3 Hz-23 kHz, minimum frequency response.
 - 2) Signal Generator; pink noise, white noise, sweep, sine wave and impulse
 - 3) Spectrum Analyzer; NTi XL2 or equal
 12. Include certification of ownership and full familiarity with the operation of the following minimum software and analysis tools:
 - a. AutoCAD, version as required by the Owner (or .dwg compatible software, Stardraw not acceptable).
 - b. Revit, version as required by the Owner; or other BIM software, version as required by the Owner.
 13. BIDS NOT FULLY ITEMIZED OR NOT SUBMITTED IN THIS FORMAT WILL BE REJECTED.
- F. Delivery Schedule:
1. Unless otherwise directed in Division 0, within 14 days of receipt of bid package provide:
 - a. Basis of bid documents, including:
 - 1) Itemized equipment costs for specified equipment or APPROVED substitutions.
 - 2) Qualifications/References
 - 3) Certifications (including certificate of bonding, if required)
 - 4) Proposed payment terms.

1.07 QUALITY ASSURANCE

- A. Project Management: Maintain the same person in charge of work throughout installation. Engineering and construction supervisors shall be CTS-I certified.

- B. Contract Documents: Maintain a complete set of the latest version of system drawings and specifications, including any redlines, at the site at all times during installation.
- C. Fabrication and Installation: Fabricate all equipment racks and subassemblies. Make field connections of all audio, video and control wiring including microphone, line level, loudspeaker, video, and control system circuits to equipment, equipment racks and connection panels. Continuously supervise the installation and connections of cable and equipment.
- D. Audiovisual System Contractor Qualifications: To be considered qualified for this work, bidders must meet the following standards:
 - 1. The Contracting firm is experienced in the provision of audiovisual systems similar in complexity to those required for this project.
 - 2. The Contractor's primary business is the provision, fabrication and installation of professional video and related systems.
 - 3. The Contractor has been regularly engaged in the installation and service of professional audiovisual systems for a period of at least five years.
 - 4. The Contractor is an authorized dealer for the major products furnished.
 - 5. The Contractor retains current accreditation through the ISCA/CTS program.
 - 6. Additional certifications specific to project - (DMC-E-4K, XTP-E, etc.)
 - 7. At the request of the Owner, Owner's representative, or Architect, demonstrate the following capabilities:
 - a. Adequate plant and equipment to complete the work in accordance to the project schedule.
 - b. Sufficient staff with appropriate technical experience to oversee and execute the work.
- E. Subcontractors: The Contractor may arrange for sub-contract field and special shop work to be done by others.
- F. Prime Contractors: Any other installer who intends to bid on this work as the Prime Contractor and does not meet the "Contractor Qualifications" described above shall employ the services of a single "Audiovisual Systems Contractor" who does meet these requirements. The Audiovisual System Contractor shall Furnish and Install the equipment. The Prime Contractor shall clearly identify the Audiovisual Systems Contractor and submit complete qualification information for the Audiovisual Systems Contractor in the Bid. Failure to do so will be cause for rejection of the Bid.

1.08 SUBSTITUTIONS

- A. General:
 - 1. The Audiovisual Systems Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Architect, that the proposed product is similar and equal to the named product.
- B. Documentation:
 - 1. File a formal request for each substitution, documenting the conditions outlined below, including:
 - a. Complete data on the proposed substitution, substantiating compliance with the Audiovisual Systems Contract Documents, including:
 - 1) Specification Section and description of the equipment or service originally specified by the Audiovisual Systems Consultant
 - 2) Product manufacturer, model, and description of the proposed substitution
 - 3) Performance specification and test data verifying the proposed substitution's compliance with Audiovisual System and installation requirements.

- 4) References and samples, where applicable
 - 5) An itemized comparison of the proposed substitution with the item originally selected in the Audiovisual Specification
 - 6) The impact of the proposed substitution on the Contract time schedule, system design, artistic effect (for changes in finish or dimension), and related contracts and trades
2. Submit item comparisons, coordination schedules, and design impact via addenda appended to manufacturer documentation.
- C. Basis:
1. Requests for acceptance of proposed equivalents made following the award of bid are considered only in the following cases:
 - a. The named products cannot be obtained by the Audiovisual Systems Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Audiovisual Systems Contractor makes a written request for consideration of the proposed equivalent.
 - b. The proposed equivalent is approved as equal or superior to the named product and its use is to the advantage of the Owner.
- D. Consideration:
1. A request for substitution is a representation by the Audiovisual Systems Contractor that:
 - a. The Audiovisual Systems Contractor has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - b. The same warranty is provided for the substitution as the original equipment specified.
 - c. The cost data presented is complete and includes all related costs under this Contract but excludes costs under separate contracts and excludes Architect's re-design costs, and that the Audiovisual Systems Contractor waives all claims for additional costs related to the substitution which subsequently becomes apparent.
 - d. Any cost impact on work by other trades is indicated.
 - e. Installation of the accepted substitute will be coordinated by the Audiovisual Systems Contractor, making such changes as may be required for the Work to be complete in all respects.
 2. An accepted substitution shall be documented by Change Order, effectively modifying the Audiovisual Systems Specification. The Contract Price will be changed only if the substitution results in cost savings to the Owner.
- 1.09 CONSTRUCTION SUBMITTALS
- A. Coordinate all submittals with requirements set forth in Section 013300.
 - B. General: Unless directed otherwise in Section 013300,
 1. Provide six (6) hard copies of all submittals (including USB flash drives) and final deliverables per site location unless otherwise directed by the project manager.
 2. Delivery Schedule:
 - a. Within 21 days of award provide:
 - 1) Bill of Materials
 - 2) Manufacturer Catalog Data Sheets: Product Submittals shall be issued no sooner than six (6) months prior to scheduled installation onsite.
 - 3) Shop Drawings
 - 4) Custom finish material samples, if applicable.

- b. One week before acceptance testing visits (system “check-out”) provide:
 - 1) System test and certification reports
 - 2) Manufacturer’s owner’s manuals
 - 3) One (1) draft copy of user operational manuals
 - 4) One (1) draft copy of “as-built” system diagrams
 - c. Within 30 days after final acceptance testing visit provide:
 - 1) As-built system diagrams
 - 2) User operational manuals
 3. Unless otherwise directed by contract, do not order equipment until the Bill of Materials, Catalog Data Sheets, and shop drawings have been reviewed and approved by the Owner, Owner’s representative, or Audiovisual Systems Consultant. Any acquisition, assembly or installation of any systems or components without Audiovisual Systems Consultant’s approval will be subject to removal at the Audiovisual Systems Integrator’s expense.
 4. Approval for isolated items will not be considered, except by prior authorization by the Audiovisual Systems Consultant.
 5. All rejected items and items requiring correction must be resubmitted together in entirety, unless otherwise approved.
 - C. Binders:
 1. Provide indexed tabs and flyleaf for each separate product, or each piece of operating equipment.
 2. Commercial quality three-ring binders with durable and cleanable plastic covers, 1" minimum, 2" maximum ring size
 3. When multiple binders are used, collate the data into related consistent groupings.
 4. Provide product data sheets in electronic .pdf format, or other approved file format. Data sheets shall be organized in a logical manner, such as per system, to allow efficient review against the design documents.
 - D. Bill of Materials & Manufacturer Product Data Sheets:
 1. Organize the Bill of Materials with the information presented in the order and format that it appears in this specification.
 2. After the Bill of Materials, include Catalog Data Sheets (“cut” sheets) for all specified products arranged in the order listed in the Bill of Materials.
 3. Clearly indicate all finishes, colors and, options for equipment.
 - E. Shop Drawings:
 1. Size: minimum 24” x 36” unless otherwise specified.
 2. Media: provide in electronic .pdf file format unless otherwise specified or directed by the Construction Manager.
 3. Prepare a drawing package on the approved Computer Aided Drafting (CAD) or Building Information Modeling (BIM) system, including:
 - a. Audiovisual Systems Integrator name, address, and phone number.
 - b. Block diagrams indicating proposed connections of all equipment and indicating equipment brand and model numbers.
 - c. DSP Settings: Schematic diagram of processing blocks and signal flow in CAD, printed block diagram with settings from manufacturer’s software, or saved software settings and manufacturer’s authorized DSP editing software on USB flash drive.
 - d. Equipment/ control room layout and equipment rack and cabinet details
 - e. Provide detailed drawings of custom-fabricated or stock mounts and hardware.

- f. Video display arrangements.
 - g. Flown loudspeaker arrangements.
 - h. Shop drawings of any unit to be fabricated or modified under the scope of the Audiovisual Systems Integrator such as control panels, switch panels, loudspeaker enclosures or grilles.
 - i. Detailed control panel layouts and control logic notes prepared by the control system programmer:
 - 1) Provide engraved button labeling details or page graphics (including text, button colors, images, and backgrounds) as well as page flips, sub-pages and overall command logic flow.
 - 2) Audiovisual Systems contractor may choose to submit control panel information under separate cover, bound into a commercial quality three-ring binder.
 - j. Other drawings and sketches as required by the Architect or Audiovisual Systems Consultant during the course of project installation.
4. Design drawing files provided by the Architect and/or Audiovisual Systems Consultant as a courtesy in aiding the Audiovisual Systems Integrator in preparing Shop Drawings must be modified to include the information specified above. Submitting design drawings without these modifications is not acceptable.
- F. Data Network Connectivity
- 1. Any system, or components of a system, provided in this specification section which are to be connected to the Owner's data network either via wired or wireless connections will conform to the requirements described in PART 3 - EXECUTION. Vendors shall review the requirements of this section and provide a statement of compliance for each item that either:
 - a. Confirms that the proposed System (or any applicable components of the System) is compliant with the requirements listed in the item, or
 - b. Explains why the proposed System (or any applicable components of the System) is not compliant, including any potential mitigation measures that may resolve the non-compliance issue.
- G. Control System Software Submittals
- 1. Control System Software consists of the following two primary components:
 - a. Control System Graphical User Interface (GUI)
 - b. Control System Processor Software
 - 2. In order to develop Control System Software that is functional and understandable by the intended users, it will be necessary for the Audiovisual Systems Integrator to provide "working" copies of software for review and comment by the Owner and the Project team as it is being developed.
 - 3. The software programming process must be an iterative process that includes a minimum of three (3) iterative submittals prior to first beneficial use. The following table is provided to help facilitate the software development process:

Deliverable	Notes	Due
Initial Submittal	Listing of individual device control functions GUI logic flow diagram Static touch panel layouts Initial labeling of button panels	Due no later than one week after return of approved shop drawings
First Beta Review	Dynamic touch panel Layouts including page flips, pop-ups, feedback, etc. to show operational relationships between pages	Due no later than two weeks after return of approved Initial Submittal
Second Beta Review	Interface updates and revisions Test of loaded working system (in shop or on site)	Due no later than three weeks after return of approved First Beta Review submittal
Implementation / On-site Testing	Loading of live code into working systems	Prior to Substantial Completion
Completion	Follow-up programming review and minor modifications based on user feedback	60 days after Final Acceptance

H. Project Plan

1. Provide a complete and detailed Schedule for the Audiovisual Systems Integrator's work describing the major tasks, sequence of work, submittals and other critical milestones. At a minimum, the tasks noted in the Schedule shall include all required submittals, rack assembly and shop testing, on-site cable installation, periodic shop and site visits, on-site equipment installation, testing and commissioning, Substantial Completion and Project Completion. Indicate the sequence of installation and completion by room and/or system. The Schedule shall also include anticipated dates of acquisition of major equipment and their installation milestones.
2. Provide a complete listing of the Audiovisual Systems Integrator's project team, including the names and all contact information (email address, cell phone, etc.) for all personnel assigned to the Project. At a minimum, this Project Team Directory shall include the Audiovisual Systems Integrator's executive in charge of the Project as well as the Project Manager, Lead Engineer and Lead Installer. Include names and contact information for all sub-contractors.

I. Weekly Status Reports

1. If directed by the Construction Manager, the Audiovisual Systems Integrator shall provide weekly progress updates to the Architect and Audiovisual Systems Consultant. Weekly Status Reports shall be submitted as directed by the Construction Manager via hard copy or electronic means (i.e. email). Issuance of Weekly Status Reports shall commence from the date of the first submittal delivery and shall continue until contract closeout.
2. The Weekly Status Report shall not be used as an official means of communicating Project issues. It does not replace any part of a required submittal, request for information, proposed change order, report of field conditions, schedule issues, etc. No official response will be given to the Weekly Status Report.

3. A representative of the Audiovisual Systems Integrator shall attend the weekly construction meeting, or as directed by the Construction Manager, at the job site. This representative shall be fully knowledgeable in all aspects of the Project and the Audiovisual Systems Integrator's work and shall have the authority to make binding commitments on behalf of the Audiovisual Systems Integrator.
- J. Substantial Completion Submittals
- Substantial Completion of the Audiovisual System installation shall be the point at which all Audiovisual Equipment has been installed, programmed, configured, and initially tested to confirm proper operation. The point of Substantial Completion shall be as mutually agreed between the Audiovisual Systems Integrator and the Audiovisual Systems Consultant following discussion and observation. At the point of agreed Substantial Completion, the Audiovisual Systems Integrator shall submit the following:
1. Test Reports:
 - a. Upon completion of SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS specified in PART 3 - EXECUTION, submit for approval in writing test results including numerical values for all measurements.
 - b. Submit written certification that the installation conforms to specifications, is complete and operable, and is ready for FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION.
 - c. The Owner or Owner's representative reserves the right to withhold the final site visit "check-out" and any final certification of project completion until receipt of test report documents, as outlined in this section (SECTION 1 – "Test Reports").
 2. Preliminary Project Record Documents Submittal
 - a. Upon Substantial Completion the Audiovisual Systems Integrator shall submit Preliminary Project Record Documents to the Audiovisual Systems Consultant. Preliminary Project Record documents shall be submitted prior to the Preliminary Checkout.
 - b. Preliminary Project Record Documents shall include:
 - 1) Corrected/updated shop drawings
 - 2) Updated Equipment List
 - 3) Half-size drawings modified to reflect the actual installation conditions
 - 4) USB flash drive or other approved media with manufacturers' operation manuals arranged alphabetically and current drawings in .DWG format
 - c. Audiovisual Systems Consultant's Preliminary Checkout will be scheduled after the Preliminary Project Record Documents and Test Reports have been approved.
- K. Manufacturer's Owner's Manuals:
1. Archive all Manufacturers' Owner's Manuals for specified equipment in the following manner:
 - a. One original (not photocopy) manufacturer's owner's manual per equipment item.
 - b. Submit in a 3-ring binder including a cover page and spine insert identifying the project, site location and submittal.
 - c. Arrange manuals in alphabetical order, by manufacturer.
 - d. Provide a table of contents and separate each section within the binder with tab dividers.

- e. Provide all Manufacturer's Owner's Manuals in electronic .pdf format on USB flash drive or other approved media. Owner's Manuals shall be organized in a logical manner such as per system and/or alphabetical order, by manufacturer.
- L. User Operational Manual:
1. Intent: Prepare in the form of a system operations manual for use by Owner's personnel. System documentation shall be adequate such that a person trained on the System, but with no familiarity with this specific implementation, shall be able to understand the configuration and implementation of all major and minor systems as well as how these systems are integrated to form the overall System.
 2. Cover: Identify each volume with typed or printed titles "SYSTEM OPERATING INSTRUCTIONS".
 3. Format: Submit the User Operational Manual in the following format:
 - a. Size: 8-1/2" x 11", 20 lb. minimum weight white paper for typed pages, either manufacturer's printed data, or neatly typewritten.
 - b. Drawings: Provide reinforced punched binder tab, bind in with text. Fold larger drawings to size of text pages.
 - c. Provide Operational Manual in electronic .pdf format on USB flash drive or other approved media.
 4. Content of Manuals: Prepare the User Operational Manual with the following content:
 - a. Neatly typewritten table of contents for each volume, arranged in systematic order. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - b. Contractor name of responsible principal, address, and telephone number
 - c. Certificate of Warranty
 - d. Service Contract: Include a preliminary schedule for the specified semi-annual site visits.
 - e. Complete as-built diagrams for systems.
 - f. Receptacle Location Plan
 - g. Shop drawings of all custom-fabricated items
 - h. Control Setting Schedule.
 - i. Documentation of all touch-panel screens both in the form of data files on USB flash drive, or other approved media, and graphical printouts.
 - j. Audiovisual control system programming files on USB flash drives, or other approved media, for the control system, the touch screen display program, and all programming, graphics, communication, or other software required for re-programming the AV control system.
- M. System Diagrams:
1. Provide sufficiently clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation, based on diagrammatic representations of the installed system.
 2. Provide drawings showing all terminal blocks, connectors, relays, switches, equipment, components, and wires.
 3. Provide layout drawings of panels and other custom assemblies containing switches, relays, terminal blocks, receptacles, etc., using reference numbers to identify physical locations of devices or label devices with reference numbers in a location visible while viewing cable terminations.
 4. On wiring diagrams, label all conductors within cables for insulation color or other identifier.

5. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number.
 6. If device does not provide terminal designations, provide key diagram for reference.
 7. Label all devices with manufacturer, model number, and reference number (e.g. "SW 15", "TB 6"); reference numbers shall be consistent across all drawings with no repetitions.
 8. Provide labels for cables continued onto another drawing, indicating termination device, terminal numbers, and drawing sheet on which the termination is shown.
 9. Illustrate all receptacles, patch panel jacks, and switches.
 10. Mount one photographic, wash-off Mylar or rag paper photocopy prints of each system behind acrylic at locations to be determined.
 11. Receptacle Location Plan: Plan drawing of area showing locations and designations of all receptacles.
 12. Control Setting Schedule: Fully document the settings of all non-user-adjustable controls. This includes power amplifier gain controls, equalizer settings, etc.
- N. Samples:
1. Advance Finish Samples for Approval/Coordination: Provide advance samples of finish for custom control panels and other custom items specified and provided by the Audiovisual Systems Contractor, as mandated within this document.
 2. As-built Finish Samples for Archiving: For future repairs or modifications, include source information and samples for any custom finish or material including custom control panels and other custom items provided by the Audiovisual Systems Contractor.
- O. Forward all submittals to:
1. The Construction Manager, or as directed.
- P. Sustainable Building Submittals
1. Sustainable Building Submittals are required to verify compliance with the "Sustainable Building Performance Criteria" defined in this section.
 2. Refer to Division 1 Section "Sustainable Design and Construction," for detailed descriptions of the submittal documents listed below.
 3. Green Building Materials Certification Form (GMF): Submit a completed GMF for the materials included in this section (blank copy is appended to Division 1 Section "Sustainable Design and Construction"). The following information shall be provided:
 - a. Itemized material costs for the Green Building Focus Material (GBFMs) identified under the "Sustainable Building Performance Criteria" heading of this section.
 4. Supplementary Information: In addition to the GMF, the following Sustainable Building submittal information shall be provided per Section 01 81 13:
 - a. GMF Back-Up Documentation
 - b. Product Cut Sheets
 - c. Verification of lack of Prohibited Compounds in Adhesives, Sealants, and Sealant Primers.
 - d. Energy Star Label Certification (Note: only include where applicable).
- 1.10 SUSTAINABLE BUILDING CRITERIA
- A. Green Building Focus Materials (GBFMs) for this Section:
 1. Audiovisual Equipment
 2. Field-applied sealants, adhesives, paints, and coatings.
 - B. All applicable Audiovisual products purchased under this section shall be "EnergyStar" labeled under the U.S. EPA/DOE EnergyStar program.

- C. Provide all field-applied adhesives, sealants, paints and coatings that meet the volatile organic compound (VOC) and chemical component limitations as defined under Section under Section 01 81 15 - Limits for Volatile Organic Compound Contents for Adhesives, Sealants, Paints and Coatings.
- 1.11 JOB CONDITIONS
- A. Sequencing and Scheduling:
 - 1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
 - 2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
 - 3. Staff the job to keep pace with the other Trades; otherwise, the project manager will require an increase in force or overtime work without additional expenses to the Owner.
 - 4. Abide by the decision of the project manager in case of conflict or interference by other trades.
 - 5. Remove all refuse from the job site to the satisfaction of the Owner's representative.
 - B. Do not install equipment in dusty conditions or allow dust to accumulate in or on installed Audiovisual Equipment.
 - C. Protect all work and equipment from damage by others.
 - D. Protect all existing work-in-place by others from damage by the Audiovisual Systems Integrator, the Audiovisual Systems Integrator's agents and/or sub-contractors, or any employees or vendors. The Audiovisual Systems Integrator will be solely responsible for any/all damage to work-in-place by others.
 - E. Keep areas around and inside of each piece of equipment and each rack free from dust, dirt, and debris throughout the project. Equipment that is not properly maintained during installation shall be replaced at no cost to the Owner before final payment is made to the Audiovisual Systems Integrator.
 - F. Storage and Staging:
 - 1. The Audiovisual Systems Contractor is ultimately responsible for acquiring secure storage at the job site. Coordinate with project management and/or Owner to determine the location and size of the storage area.
 - 2. All Audiovisual Systems Integrator equipment and materials and all owner furnished equipment turned over to the Audiovisual Systems Integrator stored at the Audiovisual Systems Integrator's facility(s) or stored and/or installed at the Project site will remain the property of the Audiovisual Systems Integrator unless ownership is legally transferred and accepted in writing by the Owner. The Audiovisual Systems Integrator shall be solely responsible for the protection of all equipment from damage, theft or vandalism regardless of cause, until the work described herein is accepted by the Owner at the time of Final Checkout.
 - G. Refuse and Repair:
 - 1. Upon completion of work remove all associated debris, waste, refuse, and rubbish from premises. Leave all areas and equipment within the scope of this contract clean, free of blemishes, and operational.
 - 2. Repair any damage to the premises, at no cost to the Owner, caused by the Audiovisual Systems Contractor, its agents, and/or subcontractors.
 - H. Adhere to the safety standards established by the General Contractor while performing work on site.
 - I. All employees of the Audiovisual Systems Integrator shall wear identification clearly indicating the Audiovisual Integrator's company name while on site.
 - J. All employees of the Audiovisual Systems Integrator shall comply with rules and policies established by the Owner and/or the General Contractor.

- K. All vehicles of the Audiovisual Systems Integrator or employees shall be parked in areas designated by the Owner and/or the General Contractor.
 - L. Environmental Impact Considerations
 - 1. The Audiovisual Systems Integrator is expected to comply with project specific practices and environmental considerations to comply with any LEED objectives and local environmental regulations.
 - 2. The Audiovisual Systems Integrator is encouraged to utilize environmentally sustainable materials and work practices in the delivery of the Work. This may consist of (but not be limited to):
 - a. Energy Efficiency/Conservation
 - b. Waste Reduction/Recycling
 - c. Water Conservation
 - d. Pollution Prevention
 - e. Employee Education Programs
 - f. Transportation Planning
 - g. Utilization of Renewable Materials
 - h. Minimize Emission of Greenhouse Gases
 - 3. Upon request, the Audiovisual Systems Integrator shall supply documentation on in-house policies for recycling and environmental offset goals.
 - M. Promotion/Publication:
 - 1. The contractor does not have the rights to use any information or images, relative to this contractor installation, for publication or in promotional materials without the express written permission of the Owner, Architect, and Vantage Technology Consulting Group. Upon approval, the contractor must disclose full credit to the Architect and Consultant for facilities and system design.
 - N. Insurances on the work of this specialty trade shall be provided as specified in relevant project documentation.
 - O. Inspection
 - 1. Notify the Architect of any defects in work by other trades affecting installation.
 - P. Packaging: Material and equipment manufacturers shall demonstrate efforts to reduce packaging waste and/or to use environmentally friendly packaging materials. Examples include, but are not limited to, the following:
 - 1. Reusable and/or returnable pallets or crates
 - 2. FSC-certified wood or salvaged wood pallets or crates
 - 3. High recycled-content cardboard, paper, steel, or plastic packaging
 - 4. Bio-based foam packing materials
- 1.12 DESCRIPTION OF SYSTEMS:
- A. Project Description
 - 1. The project concerns the installation of new audiovisual systems in new spaces at the Ceaser Chavez Administration and Workforce Replacement Building in Monterey Park CS, as described below and shown on the drawings.
 - 2.
 - B. Functional Requirements of Systems:
 - 1. General Classroom
 - a. In order to facilitate instruction in the General Classroom a media presentation system will be provided. This system will comprise of a ceiling-mounted video projector and ceiling-recessed widescreen motorized projection screen to facilitate video display.
 - b. Ceiling-mounted loudspeakers are provided to reproduce media audio.

- c. A small form factor computer with wireless keyboard, mouse and input interface will be provided in the instructor lectern. Additional input interfaces facilitate connection of portable devices such as laptop computers and to provide convenient control of the audiovisual switcher/controller. A wireless presentation gateway shall be provided for wireless presentations.
 - d. Primary control of the audiovisual system for the room will be provided via a touch control panel located at the instructor station.
 - e. A portable desktop color document camera located in the instructor station shall be included and will connect to the system for image magnification.
 - f. A mono RCA output connection for portable RF based assistive listening system shall be provided to accommodate ADA requirements and support all voice and program audio for the space.
 - g. Audiovisual equipment shall be housed in an equipment rack within the instructor station and shall house presentation source devices and other audiovisual processing and control equipment.
 - h. System Summary:
 - i. Digital video projector(s)
 - 1) WUXGA native resolution (1920 x 1200 pixels)
 - 2) High light output (min. 5,500 ANSI lumens)
 - j. Ceiling recessed projection screen
 - k. Widescreen matte whiteboard surface
 - l. Ceiling recessed loudspeakers
 - m. Wireless instructor microphone
 - n. Small form factor computer
 - o. Wireless presentation gateway
 - p. AV system presentation switcher (controller, switcher, amplifier)
 - q. Mono RCA output for portable ALS transmitter
 - r. Auxiliary AV input panel
2. Computer Lab
- a. In order to facilitate instruction in the Multipurpose Computer Lab a media presentation system will be provided. This system will comprise of a ceiling-mounted video projector and ceiling-recessed widescreen motorized projection screen to facilitate video display.
 - b. Ceiling-mounted loudspeakers are provided to reproduce media audio.
 - c. A small form factor computer with wired keyboard, mouse and input interface will be provided in the instructor lectern. Additional input interfaces facilitate connection of portable devices such as laptop computers and to provide convenient control of the audiovisual switcher/controller. A wireless presentation gateway shall be provided for wireless presentations.
 - d. Primary control of the audiovisual system for the room will be provided via a touch control panel located at the instructor station.
 - e. A portable desktop color document camera located in the instructor station shall be included and will connect to the system for image magnification.
 - f. A mono RCA output connection for portable RF based assistive listening system shall be provided to accommodate ADA requirements and support all voice and program audio for the space.
 - g. Audiovisual equipment shall be housed in an equipment rack within the instructor station and shall house presentation source devices and other audiovisual processing and control equipment.
 - h. System Summary:

- 1) Digital video projector(s)
 - a) WUXGA native resolution (1920 x 1200 pixels)
 - b) High light output (min. 5,500 ANSI lumens)
 - 2) Ceiling recessed projection screen
 - 3) Widescreen matte whiteboard surface
 - 4) Ceiling recessed loudspeakers
 - 5) Wireless instructor microphone
 - 6) Small form factor computer
 - 7) Wireless presentation gateway
 - 8) AV system presentation switcher (controller, switcher, amplifier)
 - 9) Mono RCA output for portable ALS transmitter
 - 10) Auxiliary AV input panel
3. Tutoring/Technology and Testing and Tutoring Center
- a. In order to facilitate instruction in the Tutoring & Testing Room, a media presentation system will be provided. This system will comprise of a ceiling-mounted video projector and ceiling-recessed widescreen motorized projection screen to facilitate video display.
 - b. Ceiling-mounted loudspeakers are provided to reproduce media audio.
 - c. Network-based ceiling camera(s) shall be included for close-circuit monitoring during testing.
 - d. A small form factor computer with wired keyboard, mouse and input interface will be provided in the instructor lectern. Additional input interfaces facilitate connection of portable devices such as laptop computers and to provide convenient control of the audiovisual switcher/controller. A wireless presentation gateway shall be provided for wireless presentations.
 - e. Support for hybrid learning shall be included comprising of a USB media hub to interface with the room computer, a room camera and instructor microphone.
 - f. Primary control of the audiovisual system for the room will be provided via a touch control panel located at the instructor station.
 - g. A portable desktop color document camera located in the instructor station shall be included and will connect to the system for image magnification.
 - h. A mono RCA output connection for portable RF based assistive listening system shall be provided to accommodate ADA requirements and support all voice and program audio for the space.
 - i. Audiovisual equipment shall be housed in an equipment rack within the instructor station and shall house presentation source devices and other audiovisual processing and control equipment.
 - j. System Summary:
 - 1) Digital video projector(s)
 - a) WUXGA native resolution (1920 x 1200 pixels)
 - b) High light output (min. 5,500 ANSI lumens)
 - 2) Ceiling recessed projection screen
 - 3) Widescreen matte whiteboard surface
 - 4) Ceiling recessed loudspeakers
 - 5) Ceiling (or wall) mounted camera for web-conferencing
 - 6) Wireless instructor microphone
 - 7) Small form factor computer
 - 8) Wireless presentation gateway
 - 9) AV system presentation switcher (controller, switcher, amplifier)
 - 10) Mono RCA output for portable ALS transmitter
 - 11) Auxiliary AV input panel

4. Dietetics Lab And Suite
 - a. Dietetics Lab
 - b. In order to facilitate instruction in the Dietetic Lab, a media presentation system will be provided. This system will comprise of three station-mounted flat panel displays to facilitate video display.
 - c. Ceiling-mounted loudspeakers are provided to reproduce media audio.
 - d. A small form factor computer with wired keyboard, mouse and input interface will be provided in the instructor lectern. Additional input interfaces facilitate connection of portable devices such as laptop computers and to provide convenient control of the audiovisual switcher/controller. A wireless presentation gateway shall be provided for wireless presentations.
 - e. Support for hybrid learning shall be included comprising of a USB media hub to interface with the room computer, two room cameras and an instructor microphone. One wall-mounted camera shall face the instructor and one to face the audience.
 - f. Primary control of the audiovisual system for the room will be provided via a touch control panel located at the instructor station.
 - g. A portable desktop color document camera located in the instructor station shall be included and will connect to the system for image magnification.
 - h. A mono RCA output connection for portable RF based assistive listening system shall be provided to accommodate ADA requirements and support all voice and program audio for the space.
 - i. Audiovisual equipment shall be housed in an equipment rack within the instructor station and shall house presentation source devices and other audiovisual processing and control equipment.
 - j. System Summary:
 - 1) Three (3) Medium format 4K commercial-grade, 75" displays
 - 2) Ceiling recessed loudspeakers
 - 3) Two wall-mounted cameras for web-conferencing
 - 4) Wireless instructor microphone
 - 5) Small form factor computer
 - 6) Wireless presentation gateway
 - 7) AV system presentation switcher (controller, switcher, amplifier)
 - 8) Mono RCA output for portable ALS transmitter
 - 9) Auxiliary AV input panel
5. Orientation Room
 - a. The Orientation Room will comprise of a wall mounted flat panel HD TV as the main video display.
 - b. A floor box will be located under the table to accommodate table surface AV input, power and data connections in a flip-up well.
 - c. A wall mounted push-button control panel will select the source or default back to the digital signage source when not in use which will also be based on system timing.
 - d. The system will be equipped with a wireless presentation gateway mounted behind the display.
 - e. System Summary:
 - 1) Medium format 4K commercial-grade, 75" display
 - 2) Wall push-button control panel
 - 3) Wireless presentation gateway
6. Interview Room
 - a. The Interview Room will comprise of a wall mounted flat panel HD TV as the main video display.

- b. A wall box will be located under the table to accommodate table surface AV input, power and data connections in a flip-up well.
 - c. A wall mounted push-button control panel will select the source or default back to the digital signage source when not in use which will also be based on system timing.
 - d. A display camera and microphone soundbar will be mounted below the display for conferencing capability.
 - e. System Summary:
 - 1) Medium format 4K commercial-grade, 75" display
 - 2) Wall push-button control panel
 - 3) Conferencing soundbar (with camera)
7. Employee Lounge & Break Room
- a. These areas shall comprise of a wall mounted flat panel HD TV as the main video display.
 - b. The digital signage source will activate the display during normal building hours.
 - c. A digital signage appliance will be located behind the display for program or department content playback. All content shown on the display will be created and provided by the College and/or LACCD.
 - d. System Summary:
 - 1) Small format 4K commercial-grade, 55" display
 - 2) Networked digital Signage appliance
8. Multipurpose Room (Divisible)
- a. In order to facilitate instruction in the three-zone divisible Multi-Purpose Room, a media presentation system will be provided. This system will comprise of five (5) ceiling-mounted video projectors and five (5) ceiling-recessed motorized widescreen motorized projection screens to facilitate video display in various configurations. The space will also accommodate the recording of the presenters as well as the audience response.
 - b. Ceiling-mounted loudspeakers are provided to reproduce media audio and can be split into three distinct zones when rooms are divided.
 - c. Three small form factor computers with wired keyboard, mouse and input interface will be provided in the instructor lectern. Additional input interfaces facilitate connection of portable devices such as laptop computers and to provide convenient control of the audiovisual switcher/controller. A wireless presentation gateway shall be provided for wireless presentations.
 - d. Primary control of the audiovisual system for the room will be provided via 12" touch control panels located at three entry door locations.
 - e. Three portable desktop color document cameras shall be included that can be connected to the system for display and shall be located in the instructor station.
 - f. Three wireless microphone systems (each with a lapel and handheld microphone) shall be included for voice reinforcement within the space. An overhead ceiling array microphone will be used in each of the three partitioned sections to capture audience response. The floor boxes will each have (3) XLR connections for additional wired microphones to support panel discussions and multiple styles of presentations within the venue. Six wired handheld microphones and six 25 ft. extension cables will be included along with two 4 ft. adjustable microphone stands. Ceiling array microphones will be included in each section to provide suitable coverage for event audience response during recorded sessions.

- g. Each of the three divisible rooms shall receive both a front and rear HD camera for both audience and presenter capture.
 - h. The cameras, content and audio (program and microphones) shall be integrated into a media bridge to accommodate both zoned/separated and combined support for web-conferencing. Multicast streaming and recording appliances will be provided to accommodate video and audio capture and live network broadcast during special presentations or Board of Trustees meetings.
 - i. Three fixed RF based assistive listening systems (ALS) shall be provided to accommodate ADA requirements and support all voice and program audio for the space. A wireless network audio appliance for providing live audio feeds to personal devices via an smart app will be included for the combined room used (to supplement the ALS equipment).
 - j. General audiovisual equipment shall be housed in a full-height equipment rack that shall house the presentation source devices and base audiovisual processing and control equipment.
 - k. Three podiums shall be included for the presenters that shall interface with three from floor box positions with recessed connection plates for power, AV and data signals.
 - l. System Summary:
 - 1) 5 Digital video projector(s)
 - a) WUXGA native resolution (1920 x 1200 pixels)
 - b) High light output (min. 6,500 ANSI lumens)
 - 2) 5 Ceiling recessed projection screens
 - 3) Widescreen matte whiteboard surface
 - 4) Zoned ceiling recessed loudspeakers
 - 5) Small form factor computers
 - 6) HD cameras (pan-tilt-zoom-focus)
 - 7) Media Bridge (web-collaboration)
 - 8) Multicast network streaming appliance
 - 9) Recording appliance
 - 10) Wireless microphones (handheld and lapel)
 - 11) Wired handheld microphones and stands
 - 12) Wired overhead microphone arrays
 - 13) Media-to-USB bridge appliances
 - 14) Wireless presentation gateways
 - 15) AV system presentation matrix switcher (controller, switcher, amplifiers)
 - 16) Digital audio signal processor
 - 17) ALS transmitters & receivers
 - 18) Wi-Fi audio appliance
 - 19) Auxiliary AV input panels
9. Large Conference Room
- a. The Large Conference Room will comprise of a large wall mounted flat panel HD TV as the main video display.
 - b. A floor box will be located under the table to accommodate table surface AV input, power and data connections in a flip-up well.
 - c. A wall mounted touch-control panel will select the source and control system functions.
 - d. A front camera and room microphone system will facilitate web-conferencing through the dedicated room computer.
 - e. The system will be equipped with a wireless presentation gateway mounted behind the display.

- 1) System Summary:
 - a) Large format 4K commercial-grade, 90" display
 - b) Ceiling speakers
 - c) Wall touch control panel
 - d) Wireless presentation gateway
 - e) Ceiling microphone array
 - f) Front wall HD camera
 - g) Media-to-USB converter appliance
 - h) Table AV input connections
 - i) Mono RCA output for portable ALS transmitter
 - j) Equipment Rack
 - k) Dedicated computer
10. Small Meeting Rooms
 - a. The Conference Rooms will comprise of a wall mounted flat panel HD TV as the main video display.
 - b. A floor box will be located under the table to accommodate table surface AV input, power and data connections in a flip-up well.
 - c. A wall mounted touch-control panel will select the source and control system functions.
 - d. A front camera and room microphone system will facilitate web-conferencing through the dedicated room computer.
 - e. The system will be equipped with a wireless presentation gateway mounted behind the display.
 - f. System Summary:
 - 1) Medium format 4K commercial-grade, 65-75" display
 - 2) Ceiling speakers (or display speakers)
 - 3) Wall touch control panel
 - 4) Wireless presentation gateway
 - 5) Table (or display soundbar) microphone
 - 6) Front wall HD soundbar camera
 - 7) Table AV input connections
 - 8) Mono RCA output for portable ALS transmitter
 - 9) Dedicated computer (micro PC) behind display

PART 2 PRODUCTS

2.01 ENGINEERING AND DESIGN

- A. Engineering and other pre-site services included in this Specification are considered furnished goods delivered to the site in a similar manner to physical materials. PART 2 of the AV specifications is for review by the AV contractor's engineering department. The contractor is responsible for reviewing the specification and drawings and providing an ENGINEERED fixed-price quotation covering the cost of all equipment and labor to install, program, warranty and service the systems described.
- B. The contractor is responsible for attending all pre-bid meetings and reviewing and understanding the systems design, functionality and intent.
- C. The owner assumes that all contractors providing bid responses have included all the necessary equipment, parts, cabling, labor, engineering, programming, project management, testing and training costs, and will not approve any additional fees or costs, unless shown and approved to be beyond the scope of the specification and drawings.

- D. The equipment identified below provides examples of the level of quality and functionality required. These are predominantly major or unusual items and do not represent a complete list of equipment. The contractor is responsible for providing all equipment necessary for fully functioning turnkey systems.
- E. Where the equipment described includes “or approved equal”, the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions to allow the owner or owner’s representative to make a determination prior to bid submittal.
- F. Where the equipment described includes “or equal”, the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions as part of the product data submittal package delivered after award of contract.
- G. Where the equipment described does not include “or approved equal” or “or equal”, the contractor shall provide only the product specified. No substitutions will be accepted.

2.02 GENERAL CLASSROOM

- A. Sources
 - 1. USB Camera: Aver PTZ310W and wall mount bracket.
 - 2. Document Camera – Epson DC-21 or approved equal.
 - 3. Wireless Presentation Gateway – Extron ShareLink Pro 500.
 - 4. Microphone Array – Shure MXA920, or approved equal, coordinate color with architect.
- B. Mixing, Processing, Routing, Distribution
 - 1. Presentation Switcher – Extron DTP CrossPoint 84 4k, or approved equal.
 - 2. HDBT Receiver – Extron DTP-HDMI-4K-230-RX, or approved equal.
 - 3. Assistive Listening System – Listen Technologies LS-30-072, or approved equal.
 - 4. Wireless Microphone System – Shure SLXD24D/B58, or approved equal.
 - 5. Media Bridge - Extron Mediaport, or approved equal.
- C. Audio:
 - 1. Ceiling Speakers: Extron FF-220T
 - 2. Amplifier: Extron MPA 601 70v, 60 watt amplifier with Extron PC101 AV Power Controller for relay power control.
 - 3. Ceiling Microphone Array: Shure MXA920S or approved equal, coordinate color with architect.
 - 4. Connection to portable ALS equipment per specification 27 51 26.
- D. Display
 - 1. Video Projector – Epson L630u projector with BMS LCD LOC IV ceiling lock mount.
 - 2. Manual (preferred) or motorized non-tab tensioned projection screen per specification section 11 52 13.
 - 3. Monitor, Primary (24”-27” diagonal): Smart Technologies SMART Podium 624 27” touch-enabled monitor mounted to left side of VESA articulating desk arm.
 - 4. Monitor, Secondary (27” diagonal): OFCI 27” monitor mounted to right side of VESA articulating desk arm. Min. resolution 1920x1080. Match LACCD latest computing standards.
- E. Control
 - 1. Control Panel – Extron TLP Pro 725T, or approved equal.
 - 2. Web-based User Interface: LinkLicense for use with touch-enabled monitors for control.
- F. Equipment Racks & Miscellaneous Systems
 - 1. Instructor Station:
 - a. Computer Comforts Sit-To-Stand desk with front and rear louvered locking doors, 14RU equipment rack. Laminate/trim color to be coordinated with the architect during product submittal.

- b. Dual-arm articulating VESA monitor mount.
 - c. Extron Cable Cubby 500 series cable well.
 - 2. Equipment Rack (Desk) & Miscellaneous Equipment
 - a. Included with Computer Comforts Sit-To-Stand desk. Include rear cooling kit to accommodate proper active/forced cooling of internal equipment. Include leveling feet to accommodate underside ventilation and cabling run into rack from bottom side. Coordinate prior to ordering with LACCD for enclosure (if not room millwork).
 - b. Middle Atlantic 2RU locking drawer #UD2 with #KYLK lock option.
 - c. Middle Atlantic 2RU clamping shelf for wireless mirroring device.
 - d. Middle Atlantic 3RU clamping shelf for PC.
 - e. Middle Atlantic power distribution unit (PDU) #PD-915R or approved equivalent.
- 2.03 LARGE CONFERENCE ROOM
- A. Sources
 - 1. USB Camera: Aver PTZ310W and wall mount bracket centered on the wall above the displays and the on the side wall.
 - 2. Wireless Presentation Gateway – Extron ShareLink Pro 500.
 - B. Mixing, Processing, Routing, Distribution
 - 1. Presentation Switcher – Extron DTP CrossPoint 84 4k, or approved equal.
 - 2. HDBT Transmitter – Extron DTP-HDMI-4K-230-TX
 - 3. HDBT Transmitter Type 2– Extron DTP-HDMI-4K-231-D or approved equal.
 - 4. HDBT Receiver – Extron DTP-HDMI-4K-230-RX, or approved equal.
 - 5. Media Bridge - Extron Mediaport, or approved equal.
 - 6. Microphone Input Panel – RDL DD-RN40 wall mounted bi-directional Mic/Line Dante interface, or approved equal.
 - C. Audio:
 - 1. Ceiling Speakers: Extron FF-220T
 - 2. Amplifier: Extron MPA 601 70v, 60 watt amplifier with Extron PC101 AV Power Controller for relay power control.
 - 3. Ceiling Microphone Array: Shure MXA920S or approved equal, coordinate color with architect.
 - 4. Connection to portable ALS equipment per specification 27 51 26.
 - D. Display
 - 1. Monitor: NEC V864Q (or approved consecutive model) 86” Flat Panel Monitor with Premier Mounts AM300 articulating wall mount.
 - 2. USB Extender: Extron UCS FTR 900 Kit (in ceiling enclosure) to support USB 3.0 and higher data rates.
 - 3. Equipment Management: Chief Manufacturing CSMP9X12 Proximity Storage Panel (one per display).
 - E. Control
 - 1. Control Panel – Extron TLP Pro 725M, or approved equal.
 - F. Equipment Rack (Desk) & Miscellaneous Equipment
 - 1. Middle Atlantic SRSR-12-2 (located within room millwork). Include rear cooling kit to accommodate proper active/forced cooling of internal equipment. Include leveling feet to accommodate underside ventilation and cabling run into rack from bottom side. Coordinate prior to ordering with LACCD for enclosure (if not room millwork).
 - 2. Middle Atlantic 2RU locking drawer #UD2 with #KYLK lock option.
 - 3. Middle Atlantic 2RU clamping shelf for wireless mirroring device.
 - 4. Middle Atlantic 3RU clamping shelf for PC.
 - 5. Middle Atlantic power distribution unit (PDU) #PD-915R or approved equivalent.

6. Six-outlet 115VAC surge power strip mounted within rack for monitor & PC, etc.
- 2.04 SMALL MEETING ROOMS
- A. Sources
 1. Conferencing Soundbar – Poly X52, or approved equal.
 - B. Mixing, Processing, Routing, Distribution
 1. HDMI Switcher – Extron SW2-HD-4K-Plus, or approved equal.
 2. HDBT Transmitter – Extron DTP-HDMI-4K-230-TX
 3. HDBT Receiver – Extron DTP-HDMI-4K-230-RX, or approved equal.
 - C. Display
 1. Wall Mounted Monitor – NEC 4P-B65EJ2U, or approved equal, with Chief universal ceiling mount kit.
 - D. Control
 1. Control Panel – Extron TLP Pro 725M, or approved equal.
- 2.05 DIGITAL SIGNAGE
- A. Source Equipment:
 1. Networked digital signage appliance. Configure settings in conjunction with LACCD IT Dept. Content provided by LACC/LACCD.
 - B. Display:
 1. Monitor: NEC V551 (or approved consecutive model) 55” Flat Panel Monitor with Premier Mounts P4263F wall mount.
 2. Equipment Management: Chief Manufacturing CSMP9X12 Proximity Storage Panel.
- 2.06 GENERAL EQUIPMENT AND MISCELLANEOUS
- A. Cabling, and Misc.
 1. Use plenum-rated versions of the cables listed below in accordance with the NEC and all local codes.
 2. Cables (Non-Plenum Applications):
 - a. Analog Microphone and Line Level:
 - 1) Twisted pairs of color-coded AWG #22 stranded conductors with overall foil shield, stranded tinned copper drain wire, and jacket.
 - 2) Belden 9451, Liberty 22-1P-EZ, or equal.
 - b. Digital Audio:
 - 1) 110 ohms, Low Capacitance STP
 - 2) Belden 1800B, Liberty 24 1p DIG-AUDIO, or equal.
 - c. Loudspeaker, Constant Voltage:
 - 1) Stranded 18 AWG
 - 2) Belden 5300UP, Liberty 18-2C, or equal.
 - d. Loudspeaker, Low Impedance
 - 1) Twisted color-coded stranded and paired conductors with overall jacket. Gauge as required or shown on drawings.
 - 2) AWG #16: Belden 5200UP, Liberty 16-2C-TTP, or equal.
 - 3) AWG #14: Belden 5100UP, Liberty 14-2C-TTP, or equal.
 - 4) AWG #12: Belden 5000UP, Liberty 12-2C-TTP, or equal.
 - 5) AWG #10: Belden 5T00UP, or equal.
 - e. Installation Cable (use for non-plenum lectern multi-pin applications only)
 - 1) Multi conductor audio, video and control cable in single PVC jacket.
 - 2) Belden, Extron, Liberty, or equal.
 - f. Precision Video Lines (use for all discreet video connections and in-rack wiring):

- 1) Low-noise coaxial cable with AWG #20 solid center conductor, polyethylene dielectric, foil-plus-copper-braid shield, and overall PVC jacket.
- 2) Belden 1505A, CommScope 5565, or equal.
- g. Precision Video Lines (use for all RGBHV combination runs > 50 feet.)
 - 1) Low-noise coaxial cable with AWG #20 solid center conductors, polyethylene dielectric, foil-plus-copper-braid shield, and overall jacket containing all 5 individually contained coaxial cables.
 - 2) Extron M59-5 BNC series, West Penn WP 8195, or equal.
- h. Precision Video Lines (use for all RGBHV combination runs < 50 feet.)
 - 1) Low-noise coaxial cable with AWG #25 solid center conductors, polyethylene dielectric, foil-plus-copper-braid shield, and overall jacket containing all 5 individually contained coaxial cables.
 - 2) Extron MHR-5 BNC series, West Penn WP 8255, or equal.
- i. CATV Trunk
 - 1) Quad-shield Series 11.
 - 2) CommScope F11SSVR, Belden 7731A, or equal.
- j. CATV Drop
 - 1) Quad-shield Series 6.
 - 2) CommScope F6SSV, or equal.
- k. Control (Cresnet, AxLink)
 - 1) Liberty LLinx-U, Belden 1502P, or control system manufacturer-certified equal.
- l. Control (serial, dry contact, etc.)
 - 1) Color-coded stranded copper conductors with overall jacket. Number of conductors as specified.
 - 2) Belden, Liberty, West Penn, or equal.
- m. Fiber Optic
 - 1) 50 or 62.5 micron multimode, or singlemode per Owner's standard.
 - 2) Manufacturer: Per Owner's standard.
- n. UTP for non-IP media transport and control
 - 1) Four-pair unshielded twisted pair cable. Exceeds requirements for Category 5e/6/6A applications, as required.
 - 2) Cat 5e: Belden 1701A, or equal. Coordinate jacket color with Owner.
 - 3) Cat 6: Belden 1874A, or equal. Coordinate jacket color with Owner.
 - 4) Cat 6A: Belden 10GX33, or equal. Coordinate jacket color with Owner.
- o. UTP for IP-based media transport and control, and data network
 - 1) Four-pair unshielded twisted pair cable. Exceeds requirements for Category 5e/6/6A applications, as required.
 - 2) Manufacturer: Per Owner's standard.
- p. Hybrid Fiber Optic Cable
 - 1) SMPTE 311M compliant: Two strands 9.2um/125um single mode fiber; one twisted pair, 24 AWG (7x32); two twisted pairs, 20 AWG (19x32); one strength member, 16 AWG stranded steel; overall braided shield, 95%
 - 2) Gepco HDC920R, Belden 7804R, General Cable 742608, or equal.
- q. HDBase-T (copper)
 - 1) Four-pair shielded twisted pair cable. Exceeds requirements for shielded Category 6 applications.

- 2) Crestron DM, or per HDBase-T electronics manufacturer's recommendations.
 - r. HDBase-T (fiber)
 - 1) 50 or 62.5 micron multimode, or singlemode per HDBase-T electronics manufacturer's recommendations and Owner's standard.
 - 2) Manufacturer: Per Owner's standard.
 - s. HDMI Video Cable
 - 1) Factory-terminated High-Speed cable assembly, verified to resolution/frame rate/data rate/distance as required.
 - 2) Extron HDMI Pro Series, Liberty HD-700 Series, or equal.
 - t. HDMI Digital Ribbon Cable
 - 1) Factory-terminated High Speed cable assembly, verified to resolution/frame rate/data rate/distance as required.
 - 2) FSR DR-PCB-HxxM, or equal.
 - 3. Cable Markers:
 - a. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap.
 - b. Acceptable Products:
 - 1) Electrovert Type C or Z.
 - 2) Brady B-702 with Alpha FIT-221 series clear tubing.
 - 3) Thomas & Betts EZCODER.
 - 4. Microphone and Line-Level Line Terminal Blocks:
 - a. Insulation displacement "punch" block.
 - b. Contact Construction: Insulation displacement phosphor bronze contact, with plastic insulator, for AWG #22, #24, and #26 solid or stranded wire, allowing 100 insertions/ withdrawals, and accepting four wires total for each connection point.
 - c. Acceptable Products:
 - 1) ADC Products UP3 with UP-W or UP-R mounts as required with one Q-814-804 wire insertion tool.
 - 2) Siemens Multiflex block with one 714 insertion tool with cutting blade.
 - B. Connectors:
 - 1. Microphone and Line Connectors (Panel Mount):
 - a. Balanced Input Receptacles
 - 1) Female gender "XLR"-type receptacles.
 - 2) Acceptable Products:
 - a) Switchcraft C3F or D3F.
 - b) Equivalent.
 - b. Balanced Output Receptacles
 - 1) Male gender "XLR"-type receptacles.
 - 2) Acceptable Products:
 - a) Switchcraft C3M or D3M.
 - b) Equivalent.
 - c. Dual Format Line Input Receptacles
 - 1) Balanced input receptacle accepting both male gender "XLR"-type connectors and 1/4" TRS phone plugs.
 - 2) Acceptable Products:
 - a) Neutrik NCJ6FK-V.
 - b) Equivalent.
 - d. Unbalanced Input and Output Receptacles

- 1) Two-conductor 1/4" phone jacks with type J-4 single-closed circuit schematic, molded plastic enclosure, and insulating molded nylon bushing.
 - 2) Acceptable Products:
 - a) Switchcraft N112A or NL112A as required.
 - b) Equivalent.
 - e. Locking 1/4" Receptacles
 - 1) Two- or three-conductor 1/4" phone jacks with locking tab to prevent accidental removal of plug.
 - 2) Acceptable Products:
 - a) Switchcraft E111L (2-cond.) or E112BL (3-cond.) as required.
 - b) Neutrik NJ3FP6C.
 - c) Equivalent.
 - f. Unbalanced Input and Output Receptacles
 - 1) Female gender phono jacks (RCA jack) with closed circuit switching and non-grounding mount.
 - 2) Acceptable Products:
 - a) Switchcraft 3512.
 - b) Equivalent.
 - g. 3.5mm (1/8" Mini) Stereo Phone Jack
 - 1) Female gender, 3-conductor, open-circuit, enclosed, panel-mount, 3.5mm (1/8" mini) phone jack.
 - 2) Acceptable Products:
 - a) Switchcraft 35HD-series.
 - b) Equivalent.
 - h. Multipin Receptacles
 - 1) Multipin connectors compatible with microphone snakes supplied. Gender and channel capacity as shown on drawings and/or equipment schedule.
2. Microphone and Line Connectors (Cable Mount):
 - a. Balanced Input Connectors
 - 1) Female gender "XLR"-type connectors.
 - 2) Acceptable Products:
 - a) Switchcraft A3F.
 - b) Neutrik NC3FX.
 - b. Balanced Output Connectors
 - 1) Male gender "XLR" type connectors.
 - 2) Acceptable Products:
 - a) Switchcraft A3M.
 - b) Neutrik NC3MX.
 - c. 1/4" Phone Plug
 - 1) Two- or three-conductor 1/4" phone jacks.
 - 2) Acceptable Products:
 - a) Switchcraft 184 (2-cond.) or 190 (3-cond.) as required.
 - b) Neutrik NP-2C (2-cond.) or NP-3C (3-cond.) as required.
 - d. Unbalanced Line
 - 1) Two-conductor RCA plug or jack connector with steel shell and internal cable clamp. Provide with minimum 2" of rubberized shrink-wrap strain relief at each connector.
 - 2) Acceptable Products:
 - a) Switchcraft 3502 or 3503 as required.
 - b) Equivalent.
 3. Loudspeaker Connectors and Receptacles (4 conductor):

- a. General: Connector system specifically designed for high power loudspeaker signal distribution, with twist type locking device. Contacts nickel-gold alloy, 250 VAC, 30 amps continuous per contact.
 - b. Cable Connectors: Four contacts, wired separately per manufacturer's recommendation for bi-amplified applications, or with pins 1+ and 1- (pins 2+ and 2- not used) for single channel applications. Cable strain-relieved with chuck type retainer for cable diameters 5-15mm (.2-.6 inch). Cable conductors attached with screws (not soldered) to facilitate field repair. Cable conductor size AWG #10 maximum. Each pair for extension cables supplied complete with one in-line coupler to permit cable linking.
 - c. Acceptable Product: Neutrik "SPEAKON" Model NL4FC with NL4MM coupler.
4. Wall or Panel Receptacles: Airtight connector compatible with above cable connectors, size 26mm W x 3mm H. Contacts wired with Faston connectors (not soldered).
- a. Acceptable Product: Neutrik "SPEAKON" Model NL4MP with Faston connectors.
5. Video Receptacles:
- a. Insulated, feed-through BNC panel jack with beryllium copper outer conductor spring for use with Series 59-type cables.
 - b. Cable termination: BNC.
 - c. Acceptable Products:
 - 1) Trompeter UBJ28.
 - 2) Kings KC-99-54.
 - 3) ITT Pomona 3846.
 - 4) Canare BCJ-JR with IU-7/16 panel isolation bushing.
6. Recessed Video Receptacles:
- a. Insulated, feed-through BNC panel jack in recessed housing to resist damage to connector.
 - b. Impedance: 75 ohms.
 - c. Cable Termination: BNC
 - d. Acceptable Products:
 - 1) Canare BCJ-JRU.
 - 2) Equivalent.
7. BNC Video Cable Connectors:
- a. BNC type for terminating video cable in conduit or video extension cables. Crimp connector with beryllium copper outer conductor spring and captive center pin, exceeding MIL-C-39012,A.
 - b. For Belden 8281 type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-299 (use KTH-1000 crimp tool, KTH-2012 die, and KTJ-43 and KTD-30 trim jigs).
 - b) Belden BNC0081 (use 9CRT012 crimp die).
 - c) Trompeter UPL-220-016.
 - c. For Belden 8281A type cable.
 - 1) Acceptable Products:
 - a) Kings 755-48-9 (use KTH-1000 tool, KTH-2178 die, and KTJ-43 and KTD-406 trim jigs).
 - b) Belden BNC0082 (use 9CRT078 crimp die).
 - d. For Belden 8279 type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-397 (use KTH-6000 crimp tool, KTH-6029 die, and KTJ-134 and KTD-26 trim jigs).

- b) Belden BNC0079 (use 9CRT026 crimp die).
 - c) Trompeter UPL-220-019.
 - e. For Series 59-type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-294.
 - b) Belden BNC0041 (use 9CRT0022 crimp die).
 - c) Trompeter UPL-220-013.
 - d) Canare BCP-C4 with one TC-0 crimp tool and TC-D-4C die.
 - f. For Belden 1505A type cable.
 - 1) Acceptable Products:
 - a) Kings 2025-51-9.
 - b) Trompeter UPL-220-014.
 - g. For Belden 1506A type cable.
 - 1) Acceptable Products:
 - a) Kings 2025-53-9.
 - b) Trompeter UPL-220-023.
- 8. RCA type connector for Series 59-Type Video Cables:
 - a. 75 Ohm true impedance matched RCA type connector.
 - b. Crimps to any Series 59-type cable.
 - c. VSWR 1.1 or less to 200 MHz.
 - d. Fully captive gold-plated center pin.
 - e. Nickel plated brass body with Beryllium copper outer contacts.
 - f. Acceptable Products:
 - 1) Canare RP-C4 series with TC-1 Crimp tool and TCD-series crimp die.
 - 2) Equivalent.
- 9. Normalled Video Receptacle:
 - a. BNC panel jack with built-in switch activated by insertion of BNC connector.
 - b. Impedance: 75 ohms.
 - c. Acceptable Products:
 - 1) TE SVJ-2T.
 - 2) Equivalent.
- 10. "F" connector for Series 59-Type Video Cables:
 - a. 75 Ohm true impedance matched "F" connector compatible with the specified cable.
 - b. Acceptable Products:
 - 1) Gilbert
 - 2) Trompeter
 - 3) T&B
- 11. IP Control/Data/Audio and Video Transport Connectors:
 - a. RJ-45 Receptacle:
 - 1) Refer to Tel/Data specification for requirements.
 - 2) Acceptable Products:
 - a) Refer to Tel/Data specification for acceptable products.
 - b. RJ-45 Modular Plug:
 - 1) Refer to Tel/Data specification for requirements.
 - 2) Acceptable Products:
 - a) Refer to Tel/Data specification for acceptable products.
- 12. Hybrid Fiber Optic Connectors:
 - a. SMPTE 304 Receptacle
 - 1) Lemo EBW.3K.93C.TLC with fiber optic contacts
 - 2) Canare FCFR
 - 3) Approved equal.

- b. SMPTE 304 Plug
 - 1) Lemo FGW.3K.93C.CLMTxxZ with bend relief and fiber optic contacts
 - 2) Canare FCM
 - 3) Approved equal.
- 13. Singlemode Optical Fiber Connectors - LC:
 - a. Refer to Tel/Data specification for requirements. If none exist, use the following:
 - 1) Small form factor, fitting in the same size opening as an RJ-45 connector.
 - 2) Duplex, handling one pair (two elements) per connector.
 - 3) Blue in color.
 - 4) Compatible with both 900 micron buffered strands and 250 micron loose tube strands.
 - 5) Maximum insertion loss, of mated pair, less than 0.5 dB at acceptance.
 - 6) Minimum return loss of greater than or equal to 50 dB.
 - 7) Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
 - 8) Meets ANSI/TIA/EIA 568-C.3 and ISO 11801 standards.
 - b. Acceptable Products:
 - 1) Refer to Tel/Data specification for requirements. If none exist, use the following:
 - 2) Commscope
 - 3) Corning
 - 4) BerkTek
 - 5) Approved equal.
- 14. Singlemode Optical Fiber Connectors - ST:
 - a. Refer to Tel/Data specification for requirements. If none exist, use the following:
 - 1) Boot color: Blue in color.
 - 2) Nominal fiber outer diameter: 125 micron.
 - 3) Maximum insertion loss, of mated pair, less than 0.5 dB at acceptance.
 - 4) Minimum return loss of greater than or equal to 50 dB.
 - 5) Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
 - 6) Meets ANSI/TIA/EIA 568-C.3 and ISO 11801 standards.
 - b. Acceptable Products:
 - 1) Refer to Tel/Data specification for requirements. If none exist, use the following:
 - 2) Commscope
 - 3) Corning
 - 4) BerkTek
 - 5) Approved equal.
- 15. HDBaseT Copper Connectors:
 - a. Shielded RJ-45 compatible with Category 6A cable.
 - b. Acceptable Products:
 - 1) As recommended by the HDBaseT electronics manufacturer.
 - 2) Approved equal.
- 16. HDBaseT Fiber Connectors:
 - a. LC or as required by HDBaseT electronics.
 - b. Acceptable Products:
 - 1) As recommended by the HDBaseT electronics manufacturer.

- 2) Approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. All types of equipment installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- B. All delivered equipment, except portable equipment, firmly fastened or held in place. "Delivered equipment" includes loudspeakers, enclosures, amplifiers, cables, etc. Apply a minimum safety factor of four (4) times the load for all equipment fastenings and supports.
- C. Take necessary precautions to prevent and guard against electro-magnetic and electro-static hum and to install the equipment to provide safety for the operator.
- D. Protect all equipment, including patch panels, connectors, receptacles, racks, consoles, and video projectors, from construction dust and debris until final acceptance of the system.

3.02 INTEGRATION/INSTALLATION

- A. Conformance to Existing Facility Standards
 1. Wherever possible provide equipment, finishes, and interfaces similar in nature to systems already in use by the Owner. Provide uniform functionality and operation to enhance ease of use and minimize instruction. Provide uniform finish and equipment to enhance the aesthetic unity of systems facility wide, and to improve end-user familiarity with equipment.
 2. Equipment Integration:
 - a. New Equipment: Unless otherwise specified, supply only new equipment (manufactured within 6-months of installation), parts and materials, and protect all equipment from construction dust and debris until final acceptance.
 - b. Equipment Handling and Wear: Operate specified equipment only as required for testing, as part of the installation procedure.
 - c. Single Source: The provision of all manufactured components, installation, wiring, and testing is the responsibility of a single audiovisual systems contractor.
 - d. All equipment and installations under this Specification shall conform to the following:
 - 1) ANSI/NFPA 70 - National Electrical Code.
 - 2) ANSI/IEEE C2 - National Electrical Safety Code
 - 3) ANSI/TIA Standards 568, 569 and 607
 - 4) IEEE/ANSI 142-2007 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 3. Equipment Quantities:
 - a. Determine and provide the quantities of installed equipment based on the Bid Documents including the plans, functional diagrams, riser diagrams, and specification.
 - b. Quantities of portable equipment are indicated in schedules contained in the drawings or specifications.
 4. Engineering and Documentation:
 - a. The system drawings indicate the general layout of the various items of equipment and their functional relationships. Layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item or parameter required for a complete installation.
 - b. The AV Contractor shall provide any incidental equipment needed in order to result in a complete and operable system even if not specified or shown on drawings without claim for additional payment.

B. Labels

1. Dry transfer, "Dymo", or other types of adhesive labels not acceptable
2. Except where otherwise specified, label each item of rack-mounted equipment and all switches, controls, and receptacles as shown on drawings and as specified.
3. Switch and Control Panels: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness - Dry transfer or other types of adhesive labels not acceptable
4. Rack-Mounted Equipment: Labels constructed of engraved and filled plastic laminate engraving stock. Designate function and input and output line(s) or loudspeaker(s) served by labeled equipment. Key all designations to system functional and patch panel diagrams. Where possible, mount labels on blank panel directly above corresponding component. For modular equipment, provide label on inside of mainframe door identifying type of module for each slot (unless there is only one type) and gain setting as established at final checkout.
5. Identification Panel: See drawings for layout and nomenclature. AV Contractor is responsible for completing all bracketed items with the appropriate project-specific information.
6. Branding and Recognition: Identification of the contractor or use of contractor logos or similar "trademarks" or "signatures" (including but not limited to touch panel graphics and color schemes, silk-screened or engraved corporate logos, copyrighted fonts, and/or custom emblazoned panels) is strictly forbidden except where explicitly indicated within the bid documents. Any unauthorized use of these marks will be rejected.
7. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on drawings.
8. Patch Panels: Labels for jacks constructed of engraved and filled plastic laminate engraving stock or printable composition material with clear plastic cover. Labels for jack rows constructed of engraved and filled plastic laminate engraving stock. Paper strips may be used as temporary labels only.
 - a. Label jacks with functional description of jack ("Main Cluster EQ Out", "Console Mic Input 4", etc.)
 - b. Color-code jack labels with different colors for microphone level jacks, input and output jacks for recording/playback equipment, miscellaneous devices such as pads or multiples, and other line-level jacks.
9. Identify all wires and cables at every termination and connection point in accordance with INFOCOMM F501.01:2015 Cable Labeling for Audiovisual Systems using the specified cable markers, unless otherwise instructed by the Owner. Use a numbering scheme that identifies all cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and C suffixes to distinguish multiple cables terminating at the same jack. Submit proposed numbering scheme for approval prior to installation.
10. Identify switches, relays, terminal blocks, etc., with reference numbers keyed to the as-built wiring diagrams.
11. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.
12. All labels and legends shall be as approved on shop drawings.

C. Racks, Cables, Connectors, and Miscellaneous Equipment

1. Wiring and Interconnections:
 - a. General:

- 1) Exercise care in wiring to avoid damage to cables and equipment.
 - 2) Make all joints and connections with rosin-core solder or approved mechanical connectors, except mechanical connectors are NOT acceptable on microphone lines. Connections to transformer leads for distributed loudspeakers may be made using properly sized wire nuts or nylon-insulated pigtail crimp connectors such as Waldom CE series. Wire nuts are not acceptable except at individual loudspeakers.
 - 3) All connections to screw-type terminals shall be made using spade lugs. Bare or solder tinned wire is not acceptable.
 - 4) All connections to lugless compression-type screw terminals shall be made using bare wire only. Do not solder tin wire.
 - 5) All wiring executed in strict adherence to standard broadcast practices. This includes:
 - a) Dress cables in conveniently sized bundles, combed into parallel runs, either laced or banded with sufficient hook and loop (Velcro) ties.
 - b) For equipment mounted on glides, or otherwise requiring servicing from the front of the rack, incorporate a cable "service loop" of sufficient length to permit the equipment to be pulled forward from the rack for servicing.
 - c) Support cables and bundles with sufficient hook and loop (Velcro) ties and support bars to ensure that no strain is placed on any connections or connectors.
 - d) Organize cables and cable bundles behind patch bays to permit easy access to the patch panels to add or remove cables.
 - e) Place cable markers 3"-5" back from video connectors to permit easy viewing. Do not bind markers into cable bundles.
 - 6) All audio signal lines carried by twisted-pair cable and switched with two poles per line unless noted otherwise. Do not tie one side of audio line to other audio lines.
- b. Grounding:
- 1) Ground equipment, racks, and audio line shields to independent audio system ground ONLY as shown on drawings. If not shown on drawings, ground case of power striplines in equipment racks to the racks and directly to isolated ground buss in the power panel or to power system ground at the building AC service entry only.
 - 2) Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including equipment racks and audio system ground.
 - 3) Insulate all conductors in conduit, including shields, from the conduit, back boxes, and from each other for the entire conduit length.
- c. Equipment Racks:
- 1) Install equipment in racks to permit access to all equipment for service. Transformers, relays, terminal blocks, etc., mounted in rear of racks behind other equipment shall not prevent access to equipment connections or shall be mounted on hinged panels to permit access.
 - 2) Wire all racks completely in the shop. No internal rack wiring to be done on the job site.

- 3) Install equipment in racks with ventilating panels as required to provide adequate ventilation and according to equipment manufacturer's recommendations.
 - 4) Connect all microphone, DC control, and line level cables to equipment racks via specified audio terminal blocks. External lines to patch bay terminated directly on patch bay terminal blocks.
 - 5) Connect loudspeaker lines with equipment racks via specified terminal blocks. Use spade lugs if barrier strips are used. Do not buss commons together. Do not ground.
 - 6) No signal or control lines shall leave a rack without connecting via terminal blocks.
 - 7) Provide unused panel space with blank or ventilating panels as shown on drawings.
 - 8) Locate free-standing racks as indicated and provide access to rear.
- d. Conduit:
- 1) Run all lines in metallic conduit or wireways unless otherwise indicated. Run microphone level, line level, loudspeaker level, and DC control wiring each in separate conduit.
 - 2) Do not locate AC power lines in conduit containing audio or video lines.
 - 3) Do not splice lines in conduit.
- e. Exposed Cables:
- 1) Line level or mic level lines exposed above countertops (such as those lines serving mixing consoles, program source equipment, etc.) shall be rubber-jacketed, AWG #20 two conductor with braided shield such as Belden 8412 or equivalent. Plastic or vinyl jacketed cables are not acceptable.
- f. Receptacles:
- 1) Provide finish sample for approval by Architect.
 - 2) Wall-mounted receptacles in metal boxes at building standard receptacle height unless otherwise indicated.
 - 3) Floor-mounted receptacles in flush floor boxes with flush lids.
- g. Video Receptacles:
- 1) Install feed-through receptacles to mounting plates with insulating washer and sleeve to electrically isolate the receptacle from the electrical box and conduit.
 - 2) Punch receptacles with "D" hole to prevent receptacle rotation within hole.
- D. Microphone Equipment
1. General:
 - a. Excluding wireless microphones, each portable microphone provided with case, stand adapter and min. 15-ft. cable with attached XLR-type connector.
 2. Cardioid Dynamic Hanging Microphone:
 - a. Locate in plan as shown on the drawings.
 - b. Locate to provide typical 6' working distance between microphone and talker; nominally <10' AFF.
 3. Wireless Microphone Systems:
 - a. Use frequency band, as required by local and national standards.
 - b. Coordinate specific transmission frequencies such that transmitters do not interfere with other wireless microphone systems within the building or other wireless systems.
 4. Beamtracking Microphones:

- a. Locate in plan as shown on the drawings or as recommended by the manufacturer to pick up talkers in the desired area.
 - b. Coordinate all network requirements including IP addresses, and VLAN and QoS requirements with the Owner's IT staff.
 - c. Configure microphone for auto-mixed output or individual channels, as shown on the drawings.
 - d. Configure lobes to cover seating area. Save presets for areas with multiple seating arrangements.
- E. Amplifiers and Signal Processors
1. Gain Control Security:
 - a. Power Amplifiers: Provide each power amplifier with calibrated, stepped controls, which are provided with tamper-resistant covers or are located on the back or inside of the chassis (contact manufacturers for gain control security options). Shaft locks or caps are NOT ACCEPTABLE. Verify acceptability of gain control security provisions with Audiovisual Systems Consultant BEFORE ordering the amplifiers.
 - b. Signal Processing equipment: Signal processing equipment with front panel controls which are to be permanently adjusted (not normally adjusted by the operator), such as equalizers, limiters, and audio delays, shall be furnished with security panels or sub panel mounted behind blank panels. Provide plastic vision panels for viewing of indicators such as meters or clipping indicators.
 2. Compressor/Limiters:
 - a. Adjust to protect loudspeaker components from overdrive damage, and to prevent amplifiers from clipping.
 3. Levelers/AGC
 - a. Adjust so that all speech inputs are normalized to the same nominal signal level. Do not apply AGC to inputs used in music performances.
 - b. Do not apply AGC to recorded content so that dynamics are preserved.
 4. Loudspeaker Management
 - a. Configure all filters, crossovers, delays, and gain controls using the loudspeaker manufacturer's supplied parameters.
- F. Loudspeaker Equipment
1. Stereo Playback Loudspeakers:
 - a. Provide detailed shop drawings for the opening dimensions and installation of loudspeakers and for the coordination of finish trades.
 - b. Mount in locations shown on drawings.
 - c. Coordinate with General Contract personnel to achieve aesthetic results as directed by the Owner or Architect.
 - d. Refer all questions and/or decisions regarding installation and finish methods to the Architect and Consultant.
 2. Ceiling Loudspeaker Assemblies
 - a. Loosely fill all enclosures with nominal 1-1/2 lb. per cu. ft. density fiberglass.
 - b. Ceiling Enclosures: Enclosures supported directly from ceiling structure in an approved manner. Support directly by acoustical ceiling tile is NOT ACCEPTABLE. Assemblies for 12" loudspeakers or larger to be supported directly from building superstructure.
 - c. Flush and Surface-Mounted Ceiling Enclosures: Provide enclosures as required, located as indicated on drawings.
 - d. Finish grilles and any exposed components per Architect's instructions.
 3. Flown Loudspeakers

- a. Provide detailed shop drawings for the installation of loudspeakers. Drawings must be stamped by a professional engineer registered in the project's jurisdiction and approved by the project structural engineer prior to installation.
 - b. Mount in locations shown on drawings.
 - c. Provide all clamps, aircraft cable, and miscellaneous hardware necessary to attach loudspeaker assemblies to building superstructure.
 - d. Coordinate with General Contract personnel to achieve aesthetic results as directed by the Owner or Architect.
 - e. Refer all questions and/or decisions regarding installation and finish methods to the Architect and Consultant.
4. Soundbars:
- a. Locate as shown on the drawings.
 - b. Provide with any hardware to wall mount, recess, or attach to top or bottom of video monitor, as required.
 - c. Ensure that all cabling is dressed neatly and either run in wireways, as shown on the drawings, or otherwise hidden from view.
- G. Video Projectors:
1. Verifications:
 - a. Indicate locations and elevations using manufacturer's throw distance and elevation formulas for proposed projector model.
 - b. Where projection screens are designed for multiple uses, verify mounting position which allows all sources to comply with specified image dimensions.
 2. Submittals:
 - a. Provide plan and section drawings verifying image width, lens-to-screen distances and mounting methods.
 - b. Provide detailed drawings of custom-fabricated or stock mounts and hardware.
 - c. Provide detailed drawings of millwork or finish items required for specified screen dimensions.
 3. Mounting:
 - a. DO NOT DISCARD ANY PROJECTOR SHIPPING OR PACKING MATERIALS. SHIPPING CONTAINERS AND MATERIALS SHOULD BE TURNED OVER TO OWNER.
 - b. Install projector mount and suspend projector at location and elevation indicated on approved shop drawings.
 - c. Projector mounts and motorized lifts must meet all applicable safety and code requirements for ceiling mounted equipment.
 - d. Fixed projector mounts must be rigid and completely free of sway or rotation deviation. Provide vibration isolation, as necessary, to ensure a stable image.
 - e. For ceiling mounted installations where screen surfaces are vertical, level projector at 0° front-to-back and side-to-side.
 - f. Position projector lens centered on screen centerline in plan.
 - g. Wherever possible, minimize hardware and cables visible from audience seating and presenter area viewpoints.
 - h. Paint exposed mounting hardware to match room interior or as instructed by Architect.
 - i. Where others provide structural mounts or millwork openings, verify correct positioning and dimensions before mounting projector. Provide written notification to the Owner or Architect of any discrepancies in mount positioning or stability deficiencies before projector installation.

- j. Provide all necessary projector brackets, fittings, pipes, miscellaneous hardware and wireways.
- 4. Alignment, Focus, and electronic testing:
 - a. Light Output: The total averaged light output from a projector, in lumens, shall be within plus-or-minus 10% of the manufacturer's published specification. Light output should be measured with a full calibrated, accepted and approved light meter.
 - b. Uniformity: The light falls off from the center of the projected image to all four corners, as measured at the projected image plane, should not exceed 50%. The light intensity should be measured at all five positions of the projected image after the projector has been adjusted to the light output as specified above.
 - c. Resolution: The projection system should be capable of producing images of the same or greater resolution as the video source equipment, up to the maximum specified resolution of the projector.
 - d. Distortion: Projected images shall not display any perceptible keystoneing or other distortion as evaluated using standard video alignment test patterns.
 - e. Contrast: The brightness ratio of the video image should be sufficient to produce good contrast as demonstrated by the even transition from black to white on the gray scale.
 - f. Adjust lensing for distortion free text.
 - g. For computer sources use approved test pattern generator.
 - h. For LCD projectors: verify color uniformity after 40 hours operation.
 - i. For Projectors containing XENON lamp systems: operate lamp for 40 hours prior to installation and color balancing/correction.
- H. Motorized Screens
 - 1. General:
 - a. Verify locations of control motors.
 - b. Where low-voltage power interfaces are specified, provide all Class-2 wiring required to interface with control systems.
 - c. Where low-voltage control interfaces have not been provided by others (even if such interfaces are defined as general contract equipment), provide low-voltage interface and all Class-2 wiring required to interface with control systems.
 - d. Control system switching shall not override or otherwise disable any local control switches provided by others.
- I. Video Monitors
 - 1. Verify that sufficient blocking has been provided by the General Contractor.
 - 2. Mount in locations shown on drawings using universal wall and ceiling mounts as specified.
 - 3. Coordinate power and wall box locations with Electrical Contractor so they are hidden from view.
 - 4. Neatly dress all cables to be hidden from view.
- J. Cameras
 - 1. Set for Auto-Iris.
 - 2. Set ABL (auto black level) off.
 - 3. Set color temperature filter to setting 1.
 - 4. Set Gain to 0 dB.

5. Determine a white-balancing procedure for normal use. Determine if an appropriate white area is available in each room or can be made available prior to each room use. If providing white surface for each day's use is difficult, evaluate the effect of using the preset 3200°K color temperature setting. Consult with Owner to confirm procedure suitability. Note that following camera shutdown, white balance, iris, and pedestal adjustments are stored in memory for a maximum of 12 hours. In the test results submission, report on findings.
 6. Set lens Macro to "OFF".
 7. Set horizontal and subcarrier phase for all cameras. Determine that all video signal parameters can be adjusted to within normal limits, with settings as described above.
 8. Coordinate pan/tilt/zoom preset requirements with Owner, and program as required.
- K. Videoconferencing Codecs
1. Securely mount hard codecs in equipment racks, as shown on the drawings.
 2. Assist Owner's IT staff in the installation and configuration of soft codecs, as required.
 3. Coordinate videoconferencing management server or software requirements with Owner's IT staff.
 4. Coordinate codec network requirements, including IP addresses and firewall configuration, with Owner's IT staff.
- L. Production Communication Equipment
1. Locate main station, remote stations, power supplies, wall stations, and speaker stations as shown on the drawings.
 2. Supply each wired belt pack with headset microphone and cable, as specified.
 3. Provide all interface devices (2-wire, 4-wire, IP, etc.) as specified or required.
 4. Verify that antennae for wireless systems will provide coverage throughout the intended areas. Notify the Audiovisual Systems Consultant immediately of any concerns.
 5. Configure master station, remote stations, and belt packs using local controls or the manufacturer's software application, per Owner's instructions or as required.
 6. Intercom-over-IP: Coordinate all network requirements including IP addresses, and VLAN and QoS requirements with the Owner's IT staff.
- M. Assistive Listening System
1. General:
 - a. Verify RF antennae, emitters, and induction loops will provide coverage throughout the intended areas. Notify the Audiovisual Systems Consultant immediately of any concerns.
 - b. Provide all receivers and accessories (ear speaker, neck loop, batteries, etc.), as specified. Coordinate turnover of all portable equipment with Owner.
 2. RF Systems:
 - a. Locate RF transmitters as shown on the drawings.
 - b. Use frequency band, as required by local and national standards.
 - c. Coordinate specific transmission frequencies such that RF transmitters do not interfere with other wireless systems within the building.
 3. IR Systems:
 - a. Locate IR emitters and modulators as shown on the drawings.
 - b. Provide detailed shop drawings for the installation of IR emitters/modulators.

- c. Verify specified emitter transmission frequency will not be adversely affected by local natural and manmade light.
 - 4. Induction Loop Systems:
 - a. Provide detailed shop drawings for installation of the induction loop.
 - b. Coordinate removal/installation of floor finishes with General Contractor.
 - N. Conference, Voting, and Simultaneous Interpretation Systems
 - 1. Confirm all microphone, button panel, and loudspeaker finishes with Architect. Locate all equipment as shown on the drawings.
 - 2. Coordinate any furniture cutout requirements with the millwork contractor. Provide cutout templates or equipment samples, as necessary.
 - 3. Neatly conceal and permanently mount all power supplies and other miscellaneous electronics, and cabling. Coordinate any access panel requirements with the millwork contractor to ensure that all components are accessible.
 - 4. Simultaneous Interpretation:
 - a. RF Systems:
 - 1) Locate RF transmitters as shown on the drawings.
 - 2) Use frequency band, as required by local and national standards.
 - 3) Coordinate specific transmission frequencies such that RF transmitters do not interfere with other wireless systems within the building.
 - b. IR Systems:
 - 1) Locate IR emitters and modulators as shown on the drawings.
 - 2) Provide detailed shop drawings for the installation of IR emitters/modulators.
 - 3) Verify specified emitter transmission frequency will not be adversely affected by local natural and manmade light.
 - 5. Coordinate turnover of all portable equipment, such as headphones and ear speakers, with Owner.
 - 6. Program all control and voting result pages as required by the Owner.
 - O. IPTV
 - 1. Coordinate server location with Owner's IT staff.
 - 2. Coordinate IP addresses, QoS, VLAN, and any other applicable data network requirements with the Owner's IT staff.
 - 3. Coordinate with the Owner's IT staff in configuring all encoder bit rates to provide the highest quality video signal with the least impact to the enterprise's data network.
 - 4. Locate all set top boxes as shown on the drawings or directed by the Architect.
 - 5. Provide media player software to Owner's IT staff. Assist in the installation and configuration of the player, as required.
 - 6. Configure channel guide in accordance with required channel lineup.
 - P. Digital Signage
 - 1. Coordinate server or software requirements with Owner's IT staff.
 - 2. Configure management and scheduling software, as required.
 - 3. Locate media players as shown on the drawings. Install players and wiring to be hidden from view while ensuring suitable ventilation and access.
 - 4. Coordinate all data network requirements with the Owner's IT staff and configure media players as required.
- 3.03 SOFTWARE
- A. Control System Software
 - 1. Graphical User Interface

- a. The Control System Graphical User Interface is the visual portion of the human interface of a touch control panel. This is the layout that the Owner and their users will operate the system by and use for navigating the various system features. Preview monitoring may also be contained in versions of the GUI.
 - b. Graphical User Interface (GUI) designs for all Audiovisual System control touch panels developed in accordance with the guidelines of the AVIXA / InfoComm International® “Dashboard for Controls Design Reference” and “Integrators Guide” for layout and flow principals.
 - c. Graphical User Interface designs shall conform to Owner’s graphic standards and guidelines for use of logos or other graphical treatments.
 - d. Coordinate and integrate requirements for lighting control presets with control panel scene recall where appropriate.
 - e. Coordinate and integrate requirements for motorized window covering and screen controls.
 - f. Set up of all video windowing software in multi-image processors whether in stand-alone units or within video projectors.
 - g. Set up of Codecs in coordination with the Owner’s videoconference and/or network support staff including any specific networking or line provisioning.
 - h. Coordinate with Owner’s data network administrator for all required IP address range and info for AV networked devices and supply any specific requirements for network parameters (MDO for switches, multicast for streaming, bandwidth, and port settings for videoconferencing, etc.). Configure and record all final IP address information and supply final listing of devices and their information to Owner’s data network administrator.
 - i. Configure all networked AV devices with appropriate settings and instruct Owner-designated personnel on how to access remotely for support of management. Tie all control system and networked AV peripherals into main Owner or specific management software package (either included in this scope or existing system) for remote control, management, and support.
2. Processor Configuration Code
 - a. The Control System Processor Configuration Code is the programming code that provides control communication between the Control System and all the Audiovisual Equipment components.
 - b. The Processor Configuration Code shall be developed by the Audiovisual Systems Integrator to enable Control System operation of all controllable device functions, whether or not those functions are made available through the GUI.
 3. Control System Software Programming
 - a. In order to develop Control System Software that is functional and understandable by the intended users, it will be necessary for the Audiovisual Systems Integrator to provide “working” copies of software as it is being developed for review and comment by the Owner.
 - b. The Control System software programming process must be an iterative process that includes a minimum of three (3) iterative submittals prior to first beneficial use.
 4. Programming Rights:
 - a. Provide all Control System Programming to the end users upon completion and approval of system installation and integration.

- b. Freely share programming graphics and blocks with the owner to ensure consistent facility-wide standards and system support. Project specific programming and graphics are not the exclusive property of the AV system contractor or programmer.
 - c. The Owner shall be granted a license in perpetuity for use.
 - d. All source code becomes the exclusive property of the Owner.
 - e. All source code changes must be fully documented. Updated programming (compiled and uncompiled hard and soft copy versions of code) must be updated and located at all equipment rack locations and for all equipment manuals.
 - f. Source code changes and/or additional programming will be warranted by the vendor for a period of 1 year with the Audiovisual Systems Integrator responsible for any required diagnosis and repair.
 - g. All manufacturers' software operating system updates, bug fixes, patches, etc., shall be installed as part of the periodic system maintenance during the Warranty period.
- B. Networked Audiovisual System Remote Management
- 1. Integrator shall coordinate with the Owner for accommodation with existing standards for remote management software to ensure compliance.
 - 2. Audiovisual Systems Integrator shall coordinate with both Owner and software manufacturer for configuration and let appropriate Owner representative manage the deployment of such software with the manufacturer.
- C. Archival System User Interface / Media Management
- 1. Archival System User Interfacing shall be required for management of locally and/or remotely stored recorded media content. This may include, but not limited to:
 - a. Configuring of FTP transfer of locally stored materials to the designated server.
 - b. Configuring the Video on Demand (VOD) server to display all managed media content by user.
 - c. Configuring the database and front-end control page(s) for content preparation and recording.
 - d. Configuring system encoders and decoders
- D. Web-Based Hardware Interfaces
- 1. Where applicable, Web-Based Hardware Interfaces may be required for remote management or configuration of Audiovisual System components. This may include digital audio mixing consoles, Web-Based camera controls, Web-Based GUI extensions. Integrator will provide technician level hardware interfaces customized for this project.
- 3.04 NETWORK CONNECTIVITY
- A. Requirements for Connection to the Owner's Network:
- 1. All IP endpoints will be provisioned using 802.1X certificate-based authentication (EAP-TLS) with a unique private certificate deployed to every device using an automated tool.
 - 2. The System shall natively support full dual-stack IPv4/6.
 - 3. If Multicast is required for the System, multicast shall be configured in PIM sparse-mode.
 - 4. All ethernet connections shall support full duplex 100/1000Mb. 10Mb half-duplex connections are not permitted.
 - 5. Any Power over Ethernet (PoE) requirements shall comply with 802.3af or 802.3at.
 - 6. Wi-Fi connections shall be compliant with at least one of the 802.11ac/ax standards. 802.11b shall not be supported.

7. All privileged/administrative user credentials shall be for named individuals. The use of shared/system accounts is prohibited except when justified by the system manufacturer and specifically authorized by the Owner.
8. Passwords for all accounts must be changed to adhere to the Owner's password policy. Contractor shall provide documentation, tools and direct support to assist the Owner in changing any passwords known to the Contractor to those only known by the Owner. Passwords must support the Owner's password policy.
9. Authentication to all System components shall be using the Owner's directory of record (e.g., Active Directory) and must support the Owner's multi-factor authentication (e.g., Azure AD MFA) and FIDO2.
10. All authentication attempts (passwords) must be encrypted at rest and in-transit using industry standard encryption mechanisms.
11. Actions by service and privileged accounts must be logged and auditable.
12. Authentication and authorization events must be captured and logged. Logs are to be sent in real-time to the Owner's log aggregation devices.
13. All Privileged access, user audit and important system and application logs must be sent to the Owner's Security Information and Event Management (SIEM) in real-time.
14. All System components shall be configured using the least-privilege model ensuring that only necessary communication is possible. Unnecessary services shall be disabled, and host-based firewalls shall be used to enforce traffic restrictions. Ingress/egress rules for System servers and handsets shall be applied to only allow only traffic that is required to ensure System functionality. Large port ranges are not to be allowed for Ingress. Ingress/Egress to the Internet shall be denied except to allow approved functionality.
15. Authorization is the determination of whether a user has permission to access particular information or applications. Proper authorization for use of an application usually requires the use of the appropriate attribute, group, and/or role as defined in the Owner's directory of record. The Contractor-provided service or application must be able to interface with the directory of record.
16. The Owner requires secure and role-based authorization for the functions and elements appropriate to the individual's role.
17. The Owner will provide any required physical or virtual servers or endpoint computers. Contractor shall provide requirements (including minimum and recommended configurations) for each System.
18. All System software, operating systems and firmware shall be the latest version and updates at the time of Substantial Completion.
19. All components must be manufacturer-supported as active products for at least 5 years after installation. The use of software in or expected to be "Extended Support" during the 5 years after installation is prohibited. Security updates must be installed for products under active support.
20. All system products must detail End-of-Sale, End-of-Support and End-of-Maintenance dates.
21. The Contractor shall configure the entire System to periodically generate backups of all system software, configuration, programming, messages, and content to an Owner-directed location.
22. All web interfaces are expected to support the current version of the following browsers including the mobile versions for iOS and Android:
 - a. Microsoft Edge (or current Microsoft browser)
 - b. Apple Safari
 - c. Mozilla Firefox

- d. Google Chrome
 23. System shall be configured in accordance with Center for Internet Security (CIS) Benchmarks. Documentation shall be provided representing how the System is configured to align with the CIS Benchmarks.
 24. The Owner limits the use of inherently insecure technologies, such as server- or client-side Java and Adobe Flash and requires that neither of these two technologies be used in or by any applications or interfaces.
 25. Application whitelisting and endpoint malware prevention shall be deployed on all endpoints. Information detailing and supporting allow-listing support must be provided by the Contractor. All provided hardware and software must be compatible without disabling or reducing the Owner's posture.
- B. Network Connectivity:
1. All network switch copper ethernet ports shall support 10Mb half-duplex as well as 10/100/1000Mb full duplex.
 2. Upon installation, Contractor shall provide a table of switch port to patch panel connections
 3. The network shall be provisioned such that each sub-system is on an isolated logical network (micro-segmentation). Dedicated and isolated segments will be setup for each connected system type and all traffic will be isolated to that logical network. Contractor will be responsible for coordinating with other project Contractors to document and configure the network in support of required firewall rules and ACLs. Where required for functionality or described in this specification, connections to other systems will be permitted but must be locked down to the minimum traffic required and approved by the Owner. Individual system Contractors are responsible for documenting and justifying any proposed approved traffic to any other system with specific sources, destinations, traffic types and port numbers (e.g., source: server 1, destination, server 1, traffic type https, TCP port 443). The Owner shall be the sole arbiter of what traffic is allowed between systems.
 4. Multicast PIM sparse-mode will be configured.
 5. Elevated or Administrative access shall be prohibited except via secure methods through an Owner bastion host.
 6. Authentication, authorization and accounting (AAA) shall be via the Owner's AAA directory of record.

3.05 REFERENCES

- A. The following documents provide information regarding audiovisual industry "best practices," including commonly accepted standards for design, installation, and performance of integrated audiovisual systems. The technical quality of the Audiovisual Systems Integrator's work and the resulting performance of the Audiovisual Systems installed in the Project will generally be measured against the standards and practices delineated in these References.
1. Audiovisual Best Practices: The Design and Integration Process for the AV and Construction Industry, Timothy Cape and Jim Smith; Fairfax, VA; International Communications Industries Association, 2005
 2. ANSI/INFOCOMM 4:2012, Audiovisual Systems Energy Management
<http://www.infocomm.org>
 3. ANSI/INFOCOMM 3M-2011, Projected Image System Contrast Ratio
<http://www.infocomm.org>
 4. ANSI/INFOCOMM 10:2013, AV Systems Performance Verification
<http://www.infocomm.org>
 5. INFOCOMM 5M-201X, Display Image Size for 2D Content
<http://www.infocomm.org>

6. INFOCOMM A102.01:2015 Audio Coverage Uniformity
<http://www.infocomm.org>
 7. INFOCOMM V201.02:2015 Direct View Display Image System Contrast Ratio
<http://www.infocomm.org>
 8. INFOCOMM F501.01:2015 Cable Labeling for Audiovisual Systems
<http://www.infocomm.org>
 9. INFOCOMM F502.01:2016 Rack Building for Audiovisual Systems
<http://www.infocomm.org>
- B. Acknowledgement of Conformance to the Standard
- a. Acknowledgment of conformance to the Standard shall include the following written statement, authored and signed by the system verifier, stating that all requirements of this Standard have been completed, the date of completion, and that the handover of the completed, verified system is finalized.

“THE SYSTEM VERIFIER ACKNOWLEDGES THAT THE PERFORMANCE OF THIS AUDIOVISUAL SYSTEM HAS BEEN VERIFIED IN CONFORMANCE WITH ALL REQUIRED PROCESSES AND CONTAINS ALL REQUIRED ELEMENTS AS DOCUMENTED WITHIN INFOCOMM 10:2013 AUDIOVISUAL SYSTEMS PERFORMANCE VERIFICATION.”

SYSTEM VERIFIER

DATE

3.06 FINAL ADJUSTMENTS AND ACCEPTANCE TESTS

- A. Upon approval of the contractor's test report, and at a time set by the Owner or Owner's authorized representative, perform final system adjustments and acceptance tests. Provide all labor, material, tools, and measurement equipment necessary for these tests and adjustments, including the test equipment and material specified in Article 1.1, except as otherwise specified.
- B. The contractor's representatives performing these tests shall be thoroughly familiar with all details of the system and shall include the field supervisor in overall charge during the course of the installation work.
- C. Budget eight (8) working hours for the performance of these tests and adjustments. If final acceptance is delayed beyond this period because of installation not in accordance with these specifications, pay for all additional time and expenses of Owner-designated observers during any resultant extension of the acceptance testing period.
- D. Measurement of frequency response, distortion, noise, or other characteristics may be performed on any item or group of items deemed necessary to determine conformity with specifications.
- E. Adjustments: Adjust the system as instructed by the Audiovisual Systems Consultant.

3.07 TRAINING

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.
- C. After the completion of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS, provide on-site training to the end-user to instruct them on the proper use of each system, including:
 1. Conduct a separate training session for each discreet system type installed.
 2. Explain operation of control systems and overall function of installed systems to staff selected by the Owner as “requiring general instruction”.

3. Explain operation of control systems, set-up and operation of individual pieces of equipment (including booth equipment), functions of overall systems, and rudimentary service guidelines to staff selected by the Owner as "requiring technician level instruction".
 4. If requested by the Owner, record these training sessions, and provide them to the Owner for future reference by the Owner's personnel.
 5. After successful training, a repair sequence (schedule of responsibility, response tree, etc.) should be established with any "technician level" staff, designated by the Owner as responsible for audiovisual systems operation and maintenance, to expedite service calls.
- D. Separate from the bid response quotation; provide an hourly cost for additional training.
- 3.08 WARRANTY
- A. Unless otherwise described in Division 01, provide for the warranty of each delivered system under the following terms and exclusions:
- B. Basic Warranty
1. Basic Warranty provided by the Audiovisual Systems Integrator shall include repair or replacement for one year from date of Final Acceptance on all Audiovisual Systems Equipment provided (including products having a manufacturer's warranty of less than one year) and all Audiovisual Systems Integrator workmanship. Basic Warranty shall be provided at no additional cost, except in case of obvious abuse. Consumable items such as lamps, batteries, tapes, etc. are not covered by Basic Warranty.
 2. Warrant all repairs to "existing" equipment for a period of ninety (90) days.
 3. During the Basic Warranty period the Audiovisual Systems Integrator shall:
 - a. Provide telephone support within 4 hours of a call requesting service.
 - b. Provide emergency service: Within 24 hours of a call requesting service not corrected by telephone support, restore the system to operation, replacing defective materials and repairing faulty workmanship. Make temporary repairs and provide loaner equipment at no charge if defective materials cannot be permanently replaced or repaired within this 24-hour time period. Repair or replace faulty items within 72 hours of on-site service or within manufacturers' specific repair program whichever is quicker.
 4. Audiovisual Systems Integrator shall not involve the Owner with removing, re-installing equipment, shipping or receiving equipment being repaired under Basic Warranty, nor shall the Owner be responsible for any shipping or freight charges associated with any item under warranty.
 5. The Owner shall be copied with all paperwork related to any and all warranty work during the Basic Warranty period.
 6. The Basic Warranty period will commence no sooner than the date of first beneficial use by the Owner and no later than the date of contract closeout.
 7. Paint and exterior finishes, fuses, lamps, projection lamps, and video picture tubes excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
 8. The terms of individual equipment manufacturers' warranties are not diminished by the minimum warranty provisions specified above.
- C. Preventative Maintenance
1. Within the term of the one-year Basic Warranty period the Audiovisual Systems Integrator shall provide, at no additional cost, periodic Preventative Maintenance on the installed Audiovisual System to ensure proper ongoing maintenance and operation.
 2. A minimum of four (4) Preventive Maintenance visits shall be provided.
 3. Preventative Maintenance shall include, but not be limited to, the following:

- a. Adjustments to video displays
4. Reviewing control system functionality
 - a. Any other maintenance and adjustments necessary to ensure that the Audiovisual System is in proper working order
5. Any problems or issues noted by the users or other Owner representatives shall be documented and completely resolved at each of the scheduled visits.
6. Preventative Maintenance Schedule
 - a. 90 days (± 15 days) after the commencement of the Warranty Period.
 - b. 180 days (± 15 days) after the commencement of the Warranty Period.
 - c. 270 days (± 15 days) after the commencement of the Warranty Period.
 - d. 20 days (± 10 days) before the end of the Warranty Period.
- D. Extended Warranty
 1. The Audiovisual Systems Integrator may elect to propose to the Owner the offer of Extended Warranty coverage for the Audiovisual Systems. Extended Warranty shall be any optional warranty services offered by the Audiovisual Systems Integrator that expand on and complement the Basic Warranty coverage required by this Specification. Any provisions of Extended Warranty coverage shall not release the Audiovisual Systems Integrator from responsibility for performance of all requirements under the Basic Warranty coverage.
- E. Software Support
 1. The Bidder shall also offer an annual Software Maintenance contract. This shall cover all software provided as part of this system and/or written for this system and shall include routine upgrades to applications and operating systems. The Software Maintenance contract shall commence immediately after expiration of the warranty period and continue for three years. Maintenance visits will be four times per year and shall be scheduled to coincide with the periodic system maintenance of the system

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SECTION 27 51 13

MASS NOTIFICATION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Design, supply and install complete system equipment and cabling to deliver a fully operational Public Address / Overhead Paging system to meet the requirements of this specification.
1. The purpose of the Public Address Paging System (also known as the Overhead Paging System) is to be used in non-emergency application to direct staff to a location or to use in an event to aid and direct patients. It can also be used as a general-purpose communications system. It is not intended to be used as a life safety system.
 2. The option to provide background music in specific zones shall be available in the design for future expansion. An auxiliary input shall be provided with a channel to provide audio to specific zones as described later in this specification
 3. The system will allow speaker volume to be configured in day and night modes (reducing the volume at night) automatically and though out the facility. The range of volume and time of which the volume reduced shall be adjusted at the Paging System head end.
 4. The systems will be zoned so that pages can be made on a zone-by-zone basis as shown on the plans, for an entire floor or for the entire building. Pages will be made though the microphone station, phone by zone or from direct dialed extensions from facility VoIP phones. Microphone inputs will be provided as shown on plans.
 5. The system will be interfaced to the existing Public Address Paging Systems in the other campus facilities. This interface should be accomplished though the phone system, network and existing infrastructure. Upon contract award, bidder shall provide a field survey of the existing system to determine the integration requirements.
- B. Basic Services: Delivery of the work described in this specification shall include, but not be limited to, the following Basic Services:
1. Engineering and Design: The Contractor shall provide all system engineering and design necessary to develop the complete systems described herein. Engineering and Design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules and lists. Additionally, final system design and configuration with the Owner, as well as on site coordination and infrastructure installation review with the General Contractor is required.
 2. Assembly: The Contractor shall procure and assemble all hardware and equipment and any additional materials as required to deliver a completely functioning System.
 3. Software Programming: The Contractor shall perform all required software setup, configuration, and programming required to develop a complete operating system in accordance with these specifications, including all control logic and push button component faceplate or interface programming.
 4. Installation: The Contractor shall install all equipment, cable, wiring, connectors, plates and other material at the Project site per the Integrator's approved designs.
 5. Testing and Adjustment: The Contractor shall perform all tests and adjustments, shall furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this specification and the Integrator's approved engineered designs.

1.02 PURPOSE AND COVERAGE

- A. The system shall deliver intelligible speech for notification purposes, to selectable zones and combinations of zones. Telephone handsets provided as part of the networked VoIP phone / Unified Communication system are used as the input devices, NIC. In specific locations, dedicated paging microphones will be provided for direct input into the system.

1.03 DEFINITION OF TERMS

- A. Definitions of terminology used in this Specification are as follows:
- B. Owner: Los Angeles City College / LACCD
- C. Construction Manager: BuildLACCD
- D. Technology Consultant: Vantage Technology Consulting Group
- E. Work: Design and provision of the Public Address and Mass Notification System and associated equipment for the Project.
- F. Specification: The complete set of documented designs, specifications, and performance and delivery requirements delineated in this document and all referenced project documentation.
- G. Bidder / Integrator: The contracted company responsible for carrying out the Work.
- H. Provide: Supply, deliver, install, configure, test and commission.
- I. Manufacturer: The original manufacturer of the individual technology equipment components.
- J. Commissioning Date: The date at which a system is formally accepted by the Owner.
- K. Owner Furnished Equipment (OFE): Electronic equipment and other material (new or existing) to be provided by the Owner and integrated as part of the Project.
- L. General Contractor:
- M. Architect:

1.04 PROJECT SCHEDULE

- A. The procurement, installation and commissioning of the Mass Notification System shall conform to the overall Project Schedule. The Bidder shall confirm that all schedule dates can be met. Any objections, qualifications, or exceptions must be clearly indicated with the submitted Bid. Refer to Specification Section III, A for additional scheduling requirements.

1.05 FUNCTION

- A. Users shall access individual paging zones or designated groups of paging zones through the telephone handset of a designated telephone, by dialing an access number.
- B. The system shall have automatic control gain to provide constant paging speech level.

1.06 LOCATION OF EQUIPMENT

- A. Equipment Rooms.
 - 1. Headend equipment shall be located in the MDF/IDF.

2. IDF rooms will be required to house the equipment serving the various elements of the Public Address Paging System.
3. Microphone Locations: One desktop microphone shall be located at the each of the following two locations: Operations Mnager and the Director's Office. One paging microphone shall be provided at the head end in the MDF.

1.07 WARRANTY

- A. The Integrator shall warrant the Mass Notification System to be free from faults and defects in system design and workmanship. This Basic Warranty coverage shall include all custom designed equipment and the overall Mass Notification System installation. Basic Warranty shall be effective for a period of three (3) years from the date of acceptance of the Mass Notification System acceptance by the Owner.
- B. The Integrator shall warrant that all equipment, materials and components installed are new at the time of installation. No used or reconditioned equipment shall be acceptable.
- C. If equipment modification by the Integrator voids the manufacturers' warranty, the Integrator shall assume the equivalent equipment warranty.
- D. Extended Warranty - The Integrator shall propose to the Owner the offer of Extended Warranty coverage for the Public Address Paging System. Extended Warranty shall be optional warranty services offered by the Integrator and accepted by the Owner that extend, expand on and/or complement the Basic Warranty coverage required by this Specification. Any provisions of Extended Warranty coverage shall not release the Integrator from responsibility for performance of all requirements under the Basic Warranty coverage.

1.08 PERMITS AND INSPECTIONS

- A. The Contractor shall obtain all permits and inspections required for the work. All permit and inspection costs will be borne by the Contractor.
- B. The Contractor shall perform all tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.
- C. The Contractor shall obtain approvals from all authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes or additions as required and deliver certificates of acceptance, operation, and/or compliance with the "As-Built Records".

1.09 TRAINING

- A. On-Site Training
 1. The Contractor shall present, review and describe all equipment and materials to the Owner and Owner's operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified.
 2. The training shall cover the overall system, each individual system, each subsystem, and each component. The training shall also cover procedures for normal operations, failure modes with response procedures for each failure and integration with other technologies. Each procedural item must be applied to each equipment level.
 3. Duration: Provide at least 8 hours of on-site training on the Public Address Paging System to designated representatives of the Owner.

4. Training to be digitally recorded by Integrator and provided to Owner on a DVD or USB drive.

1.10 SOFTWARE SPECIFICATIONS

A. Any software developed shall include, but not be limited to:

1. Control and/or monitoring of all equipment listed within the specification and as shown on the drawings. The functions shown on the drawings are for reference only and should not be considered exhaustive or final.
2. Uncompiled source code in both soft copy and printed out in hard copy documentation. Copies (hard and soft) of the software are to be included in the systems manuals.
3. As-built logic flow diagrams are to be provided with all copies of the operation manuals and at each equipment rack.
4. Zone logic and paging control tables and database

B. The following software requirements apply:

1. The Contractor may retain intellectual rights to the operating software.
2. The Owner shall be granted a license in perpetuity for use.
3. All source code becomes the exclusive property of the Owner.
4. All source code changes must be fully documented. Updated programming (compiled and pre-compiled hard and soft copy versions of code) must be updated and located at all equipment rack locations and for all equipment manuals.
5. Source code changes and/or additional programming will be warranted by the vendor for a period of 1 year with the Contractor responsible for any required diagnosis and repair.
6. All manufacturer's software operating system updates, bug fixes, patches, etc., shall be installed as part of the periodic system maintenance of the system during the warranty period.
7. An acceptance test will be performed at commissioning during which the software and any additional code changes or upgrades must perform accurately and be error free.

1.11 SPARE PARTS

- A. Unless otherwise noted herein, provide (2%), or a minimum of one (1), of the Contractor-provided quantity of each type of Mass Notification System device.
- B. The following items shall not require spare parts provision: Connectors, conductors, patch panels, mounting components, batteries, and devices for which the system already incorporates redundant components and components or devices whose total quantity is 3 or less and whose failure would not affect any other part of the system.
- C. Submit Spare Parts Material list to the Owner for approval prior to shipment.

1.12 CODES AND STANDARDS

- A. Comply with all relevant building and electrical codes, and comply with the codes and recommended practices or industry bodies related to the public address/paging industry. In particular, comply with relevant codes and standards issued by the FCC, the UL listing body and the Standards of the Electrical Industries Association.

1.13 SHOP DRAWING & EQUIPMENT SUBMITTAL

- A. The Contractor shall obtain backgrounds and prepare and submit shop drawings, in AutoCad format (latest version), which show details of all work to insure proper installation of the work using those materials and equipment specified or allowed under the contract plans and specifications. A complete Shop Drawing submittal package shall consist of Drawings, Equipment Submittals, Acceptance Testing Plan and Training Plan. The Contractor shall provide the following information.
- B. Shop Drawings:
1. Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
 - a. Title Sheet
 - b. Reflected Ceiling Plans showing loudspeakers (including type) in their proposed locations.
 - c. Riser Diagram showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
 - d. Single-Line/Block Diagrams showing signal relationships of all controls and devices within the system.
 - e. Necessary details, including complete information for making connections between work under this Contract and work under other Contracts.
 2. Each drawing or page shall include:
 - a. Project name, Project Number and Drawing Name.
 - b. Submittal date and space for revision dates.
 - c. Identification of equipment, product or material.
 - d. Name of Contractor.
 - e. Name of Supplier / Manufacturer.
 - f. Physical dimensions, clearly identified, where applicable.
 - g. Specification references.
 - h. Identification of deviations from the Contract Documents, if necessary.
 - i. Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
- C. Equipment Submittals
1. Provide a parts list, including system type, model numbers, quantities, and specification reference for equipment, materials, components and devices.
 2. Provide Manufacturers Specification Sheets with descriptive information for equipment, materials, components and devices. Clearly delineate on each specification sheet which model numbers, options and configurations are being proposed.

1.14 PROJECT COMPLETION SUBMITTALS

- A. Project Record Documents Submittal
- B. Within 30 days after Final Checkout, the Contractor shall submit complete Project Record Documents, based on the approved Preliminary Project Record Documents. These documents shall include the following:
1. Project Record Documents shall be provided digitally on a USB drive as well as uploaded to a networked accessible cloud-based portal and shall consist of:
 - a. Digital product Information which shall consist of the following information, with section dividers -
 - b. Title page and table of contents.
 - c. Warranty Statement.
 - d. Provide a three-year system warranty. Indicate warranty start and end dates, scope of warranty and conditional limitations. Indicate excluded items.

- e. Indicate procedure for obtaining telephone support and on-site service. Include a list indicating Contractor's name, address, e-mail address and service department telephone number.
 - f. Provide placeholder dates for the preventive maintenance service calls.
2. Equipment list
 - a. Final equipment list with serial numbers (and IP address as applicable) for each device. In addition, note the ending date of the manufacturer's warranty period for each product in editable spreadsheet format.
 - b. Digital equipment manuals
 - c. Alphabetically arrange manufacturer's operation manuals.
 3. Electrical and electronic test results.
 4. Hard copy half-size set of Record Drawings.
 5. Hard copy full-size Record Drawings.
 6. On a DVD or USB drive, provide electronic copies of the following:
 - a. Software-based (un-compiled) control system code (including user interface software and control program) – if applicable.
 - b. Owner shall retain copies of all custom or purpose-created software, including original source code, for future use with, and/or upgrades to, this project only.
 - c. All software shall be written with remark statements to document function of sub-routines, macro's and program requirements.
 - d. All control, DSP and specific device application software.
 - e. All DSP programing files.
 - f. All final software configuration and final set-up settings.
 - g. All software code shall be supplied in both compiled and pre(un)-compiled form.
 - h. Final equipment list with warranty and serial number information.
 - i. Record Drawings in PDF format.
 - j. Record Drawings in .dwg format.

C. Acceptance Testing Plan

1. Submit a written document for approval detailing the test procedures to be followed by the Contractor in evaluating and proving the installed system. Include the test forms to be used for each system and for each component of each system. Include all tests required by the equipment manufacturer and by this specification.

D. Training Plan

1. Submit a training plan to be followed by training the Hospital staff in the operation and maintenance of the installed system. The proposed training program shall be designed to provide a level of basic competence with the system for selected personnel.
2. The training plan shall cover the overall system, each individual system, each subsystem, and each component. The plan shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure and integration with other technology systems.

E. Verification

1. The Contractor shall check and acknowledge all shop drawings, and shall place his signature on all shop drawings submitted to the Owner. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that the submittal fully meets the requirements of the Contract Documents.

1.15 RELATED WORK BY OTHERS

- A. The Integrator shall be responsible for coordinating and assuring the compatibility of the Paging System with all related work, materials, and/or equipment being furnished and/or installed by others. This shall include, but not be limited to, the following:
- B. Cable Containment: All conduit, wireways, connection boxes, pull boxes, junction boxes, pathways, and other accommodations for routing of low voltage signal cabling, shall be supplied by others except where explicitly noted in this Specification.
- C. Technical Power Service: All electrical panels, power receptacles, lighting fixtures, dimmers, lighting controls, and interconnecting wiring shall be supplied by others.
- D. Equipment Support Structures: Design, fabrication and installation of all structural supports required for rigid connection of equipment items to the building structure shall be supplied by others. This does not relieve the Integrator from the responsibility for providing equipment mounting hardware and attachment to structural supports provided by others.
- E. Millwork and Cabinetry: All millwork and millwork modifications required to accommodate installation of Paging System, equipment and related cabling and connections, except as may be individually identified in this Specification, shall be provided by others.
- F. Owner Furnished Equipment (OFE): Some Paging System equipment may be provided and installed by others as part of the building construction. Such building related equipment shall be as described in the Project construction documents. Additionally, there may be equipment provided by the Owner or others (e.g., new equipment purchased by Owner, existing equipment to be reintegrated) that shall require installation and integration by the Integrator. Integrator shall be responsible to supply and install control and signal wiring between paging system and other OFE systems

1.16 ALTERNATES

- A. As an add/alternate, background audio will be provided in public waiting areas.

PART 2 PRODUCTS

2.01 GENERAL

- A. Modular Construction. The system shall be comprised of programmable modular solid-state components to provide flexibility, upgradeability, future adaptability and expansion.
- B. Telephone Port Interface. The System shall be fully compatible with the Owner's phone system. Interface shall incorporate a universal telephone port interface with selectable loop start, ground start, page start, analog station port. System access shall be from designated extensions. The designated extensions shall be identified by non-volatile programming.
- C. Paging Microphones: Provide paging microphones as listed below:
 - 1. Operations Manager office
 - 2. Director's office
 - 3. Public Address Paging System Head End
- D. Pre-announcement Chime. All announcements will be preceded by a pre-announcement chime. Provide at least four selectable pre-announce chimes with variable volume.

- E. Zones and zone selection. The system shall provide zones in each building as shown on the drawings. Provide selectable single zone paging, group zone paging, emergency zone group override, and emergency all-facility page override.
 - 1. Initial Zone requirements include:
 - a. Paging microphone shall page into Zone 2 as shown on drawings
 - b. VoIP paging shall include Zone 1, Zone 2 and All-Call.
- F. Auxiliary inputs: Inputs for background music sound generator shall be available in each zone with independent volume control and mute capability.
- G. Control of other systems - additional contacts. The system shall provide one Relay Driver and two C-form contact sets per zone to control other devices, and permit all-zone mute via an external interface.
- H. Clock Driven Automated Announcement. The system shall have the capability to provide replay of pre-recorded announcements from digital storage at specific times throughout the day. Provide two hours of non-volatile digital storage

2.02 SOFTWARE CONTROL

- A. The software shall provide:
 - 1. Operation on Microsoft Windows™ operating system
 - 2. The ability to adjust any individual speaker without affecting adjacent speakers
 - 3. The ability to define and adjust groups of speakers
 - 4. Paging volume and equalization
 - 5. The ability to route and mix network audio channels to any individual speaker
 - 6. The ability to create and adjust zones for paging and music
 - 7. Reporting of all system settings
 - 8. Backup and restore functions for all system settings
 - 9. Network diagnostics
 - 10. Panic button integration
 - 11. Scheduled classroom bell and notifications
 - 12. Live broadcasting of public announcements
 - 13. 911 Alerting
 - 14. Building lockdown, evacuation & emergency notification
 - 15. Pre-recorded announcements
- B. In addition to the provided software, all system functions shall be able to monitored via SNMP (simple network management protocol) to facilitate integration into other network monitoring solutions.

2.03 AMPLIFIER

- A. The power amplifier shall be a solid-state eight-channel model employing Multi-Mode® (AB+B) output circuitry. The amplifier shall contain protection from shorted, open and mismatched loads, general overheating, DC, high-frequency overloads, under/over voltage, and internal faults.

- B. The amplifier shall contain FIT (Fault Isolation Topology), which isolates channel-specific faults and prevents them from affecting remaining channels. If an amplifier channel starts to overheat, the Thermal Level Control (TLC) circuit shall engage that channel's input compressor in an amount proportional to the amount of overheating, in order to generate less heat. If the channel becomes too hot for safe operation, the channel shall shut off, and the Thermal Indicator for that channel shall flash brightly to alert the user that a state of thermal stress or overload has caused the channel to shut down.
- C. The front-panel control shall be a power switch. Rear-mounted controls shall include Channel Level Controls and a Mode Switch. The Mode Switch (used on each consecutive pair of channels) is a four-position switch which selects among Dual 8/4 ohms, Dual 70V, Bridge-Mono 16/8 ohms, and Bridge-Mono 100V. The recommended load impedance in Dual mode shall be 4/8 and 25 ohms (70V). The load impedance in Bridge-Mono mode shall be 8/16 ohms and 50 ohms (100V). The amplifier shall be safe when driving any kind of load, including highly reactive ones. Rear-mounted output connectors shall be one four-pole terminal strip for every two channels with a touch-proof cover. Rear-mounted input connectors shall be removable Phoenix-style barrier connectors for balanced input.
- D. The power amplifier shall meet or exceed the following performance criteria. Input sensitivity for rated output: 1.4 V. Rated output with eight channels driven in Dual mode with 0.1% THD (20 Hz to 20 kHz): 175 watts per channel into 4 ohms; 155 watts per channel into 8 ohms, and 185 watts per channel (70V). Rated output in Bridge-Mono mode with four channel pairs driven at 0.1% THD (20 Hz to 20 kHz): 350 watts per channel pair into 8 ohms; 310 watts per channel pair into 16 ohms, and 185 watts per channel pair (100V). Signal to Noise Ratio below rated power (20 Hz to 20 kHz): 100 dB unweighted. Phase Response: ± 35 degrees from 10 Hz to 20 kHz at 1 watt. Frequency Response: 20 Hz to 20 kHz, ± 0.5 dB at 1 watt into 8 ohms per channel in Dual mode. Damping Factor: greater than 180 from 10 to 400 Hz. Crosstalk (below rated power, 20 Hz to 1 kHz): greater than 80 dB. Intermodulation Distortion (60 Hz and 7 kHz at 4:1, from 163 milliwatts to full bandwidth power): less than 0.05% typical. Total Harmonic Distortion at 1 watt from 20 Hz to 20 kHz: less than 0.05%. Common Mode Rejection (20 Hz to 1 kHz): greater than 50 dB. DC Output Offset (shorted input): less than 5 mV. Maximum Input Level (before input compression): + 22 dBu rms. Power Draw at Idle (120 VAC mains, all channels in 4/8 ohm mode): 58 watts. Power Draw at Idle (120 VAC mains, all channels in 70V mode): 77 watts.
- E. The amplifier chassis shall be constructed of steel with a durable black finish and shall be designed for continuously variable-speed forced-air ventilation from the front panel to the back panel. The dimensions of the amplifier shall allow for 19 inch (48.3 cm) EIA standard (RS-310-B) rack mounting. The amplifier shall be 5.25 inches (13.3 cm) tall, and 16.25 inches (41.3 cm) deep behind the rack-mounting surface. The amplifier shall weigh 36 pounds, 6 ounces (16.5 kg).
- F. The amplifier shall be Crown CTs Series or approved equal. The actual model to be determined by the number of zones required from each location.

2.04 AUDIO DSP

- A. The DSP speaker processor shall provide balanced mic/line inputs and balanced line outputs on plug-in barrier-strip connectors. Inputs and outputs shall be analog, with internal 24-bit A/D & D/A converters operating at a sample rate of 48kHz. All internal processing shall be digital (DSP). Network, Dante™, etc. buss connections shall allow sharing of digital audio within multi-unit systems.
- B. Configure processor(s) to meet total quantity of inputs and outputs required day one plus 10% expansion capability. Day one quantity shall include optional background music zones for waiting areas.

- C. Software shall be provided for creating/connecting DSP system components within each hardware unit. Available system components shall include (but not be limited to) various forms of: mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, and diagnostics. Ethernet communications shall be utilized for software control and configuration. After initial programming, processors may be controlled via dedicated software screens, third-party RS-232 control systems, and/or optional remote control devices. Software shall operate on a PC computer, with network card installed, running Windows® 2000/XP Professional. The DSP speaker processor shall be CE marked, UL listed, and shall incorporate AES48-2005 Grounding & EMC practices. The DSP speaker processor shall be compliant with EU Directive 2002/95/EC, the RoHS directive. Warranty shall be 5 years.
- D. The DSP speaker processor shall be a Biamp Tesira series or approved equal.

2.05 ZONE PAGING CONTROLLER

- A. The Paging Zone Controller shall be compatible with all standard analog port types: loop start trunk, ground start trunk, station access (analog ring-up), page port contact closure activation, and page port voice activation.
- B. The paging zone controller shall contain a zone module for up to three zones of paging with an audio output with level control per zone and shall be expandable from 3 to 12 zones. It shall also provide up to 24 programmable paging zone groups.
- C. The unit shall provide 1A @ 24V DC (+20 CU) for powering external equipment.
- D. The paging zone controller shall include two high impedance transformer-isolated background music inputs with volume control. Background music source shall be selectable per zone. The paging zone controller shall include an adjustable output limiter with threshold and active indicator. The controller shall provide override paging (using loop start trunk or page port contact closure activation) with zone group, an all-call paging zone group, an auto select paging zone group, night ringer (90V and contact closure activation) with zone group and two tone triggers (tone and duration selectable, closure activated) with individual zone groups. The unit shall include code calling with zone group.
- E. The controller shall include a flexible dialing plan for zone and zone group numbers, programmable from two to five digits. DTMF programming shall be available through the override input. It shall include DTMF block to help suppress DTMF tones from being heard over the paging system. The unit shall include programmable timers to control page duration (station and trunk) that can be inhibited.
- F. The unit shall include programmable pre-announce and confirmation tones that can be set to be heard at the speakers being paged or at the calling telephone or both, as well as a setup tone to assist in volume setting, both of which can be inhibited. The unit shall include a tone level control that sets the level for all tones. The unit shall include a night ring level control. The unit shall include a programming reset to return the system to the original factory default values.
- G. Each zone output shall provide a dual form contact rated at 2A @ 30V DC and 0.6A @ 125V AC that changes state when the zone is accessed.
- H. The unit shall allow the installer to program a number of different parameters to control the way in which the AUX relay contacts activate. The unit shall allow programming of which input events the AUX relay will respond to, whether it will respond to the event only or to a combination of the event and its place in the priority structure, and if it will respond during the event or after the event ends.
- I. It shall include non-volatile memory for setup data (no backup battery required)

- J. The unit shall be wall and rack mountable using reversible brackets included with the unit. The unit shall be C-UL approved (UL60950), FCC Part 68 Registered, FCC Part 15 Compliant, and Industry Canada CS-03.
- K. The Zone Paging Controller shall be the Bogen PCM2000 System Consisting of PCMCPU, PCMTIM, and PCMZPM modules as required or approved equals.

2.06 PAGING MICROPHONE

- A. The paging microphones shall be a dynamic desktop type microphone
- B. The microphone shall have a frequency response of 80 Hz to 15 kHz and an output level of -57 dBV/Pa.
- C. The microphone shall have a push to talk button and a separate control circuit for control of external relays.
- D. The networked paging station shall provide paging audio and control data via CobraNet®, and receive Power-Over-Ethernet (PoE), utilizing a single (CAT5) network cable to a rear panel RJ45 connector. Use of an external power supply shall be optional. A rotary encoder and LCD screen shall be provided on the front panel for programming and setup. Multiple networked paging stations may be connected to each DSP unit, by means of Ethernet switches, in either single-unit or multi-unit systems. Up to 16 simultaneous pages shall be allowed per DSP unit. Up to 16 paging priority levels shall be available, including override and lock-out capabilities. Each networked paging station shall have up to 32 programmable button operations assignable, and multiple announcement chime tone options shall be available.
- E. Networked paging stations shall be represented as functional blocks within the DSP software, which shall also include dedicated page zone routing blocks, for easy inclusion into system designs. The networked paging station shall be CE marked and shall be compliant with EU Directive 2002/95/EC, the RoHS directive.
- F. The networked paging station shall be a Biamp Networked Paging Station-1.

2.07 ANALOG TO IP AUDIO INTERFACE/GATEWAY:

- A. Each amplifier channel for zone shall include a parallel connection to an Analog to IP Audio Gateway to accommodate bridging onto the Owner network.
- B. Manufacturer to be Atlas IED, model #IP-ZCM1RMK (with rack shelf).
- C. Connect along with amplifier to accommodate high-output conditions for fields or large open public areas.
- D. Connect to trigger contact connections for notification signal start.
- E. Connect to Owner data network.

2.08 SIP VOIP PAGING SERVER

- A. Manufacturer to be Atlas IED, model #IPS-VPS (with rack shelf).
- B. Connect to trigger contact connections for notification signal start.
- C. Connect audio-in for live audio stream.
- D. Line-Out Connection to Support Analog Amps

- E. Connect to data network.

2.09 LOUDSPEAKER TYPES

- A. Provide ceiling mounted cone loudspeakers and baffles and weather/environmentally rated speakers as required throughout the areas to be covered. Provide all fixing materials and trim to suit ceiling types. Speaker located in exposed areas shall be mounted tight to the truss or ceiling location.
- B. Indoor Ceiling Loudspeakers:
 - 1. Ceiling loudspeakers shall be high quality with 4" cone drivers. Indoor loudspeakers shall provide the following minimum performance:
 - a. Nominal frequency response (+/- 7dB): 75 Hz – 20 kHz
 - b. Nominal sensitivity level: 88dB SPL (RMS), 1W @ 1m (3.3 ft)
 - c. Power handling: 16 Watts (RMS), 25 Watts (Peak)
 - d. Dispersion: 130° (2kHz, -6dB)
 - e. Nominal impedance: 8 Ohms
 - 2. Ceiling loudspeakers shall be fitted with a baffle plate for mounting in a suspended ceiling. The loudspeaker shall be supported from building structure above the finish ceiling. The Architect shall approve the grille and baffle finish.
 - 3. Ceiling loudspeakers shall be provided with all assembly accessories necessary for installation in a suspended ceiling, including, but not limited to, a rear enclosure (back can), baffle, front-mounting clips, and grille.
 - 4. Ceiling loudspeaker back cans shall have an internal volume of not less than 0.285 in³, and shall be lined with minimum 5/16" thick acoustic batting of minimum density 2 lbs./ft³.
 - 5. Ceiling loudspeakers shall also be provided with 70.7-volt line high quality audio transformers. These transformers shall have a minimum of 4 secondary tapings, with a ratio of at least 8:1 between the highest and the lowest tapings (9dB power factor). Tapings shall be clearly labeled with the wattages. Transformers shall have a maximum insertion loss of 1dB.
 - 6. Indoor Ceiling loudspeakers shall be Atlassound FAP42T or equal, with appropriate mounting hardware as required with appropriate mounting accessories and transformer as described above.
- C. Outdoor/Weatherized Paging Speakers:
 - 1. Outdoor loudspeakers shall be high quality constant directivity paging horns with integral compression driver. Outdoor loudspeakers shall provide the following minimum performance:
 - a. Nominal frequency response (+/- 6dB): 400 Hz – 7500 kHz
 - b. Nominal sensitivity level: 107dB SPL (RMS), 1W @ 1m (3.3 ft), 120 dB, 40W @ 1M
 - c. Power handling: 40 Watts (RMS),
 - d. Dispersion: 60x40° (+10 degrees)
 - e. Nominal impedance: 8 Ohms
 - 2. Loudspeaker shall be weather and UV resistant
 - 3. Loudspeakers shall be provided with all assembly accessories necessary for installation

4. Ceiling loudspeakers shall also be provided with 70.7-volt line high quality audio transformers. These transformers shall have a minimum of 6 secondary tapings, with a ratio of at least 8:1 between the highest and the lowest tapings (9dB power factor). Tapings shall be clearly labeled with the wattages. Transformers shall have a maximum insertion loss of 1dB.
 5. Outdoor loudspeakers shall be Atlassound APX40TN or equal, with appropriate mounting hardware as required with appropriate mounting accessories and transformer as described above.
- D. Indoor Ceiling Loudspeakers:
1. Manufacturer to be Valcom 8" round, model # VIP-160A-IC
 2. Speakers shall be connected to the LAMC data network for SingleWire InformaCast™ operation.
 3. Each ceiling networked speaker assembly shall provide:
 - a. A networked Power-over-Ethernet connection to the speaker controller with strain relief
 - b. An acoustically damped enclosure (plenum-rated as required) or A.C.T. suspended ceiling enclosure and speaker combined assembly
 - c. Eye-bolt for single point suspension and upward facing speaker orientation
 - d. Speaker sensitivity: 90 dBA@1Watt, 1 meter pink noise
 - e. Speaker power rating: 10 watts RMS
 - f. Speaker frequency response: 100-10,000 Hz
 - g. Device shall be ETL listed to conform to UL1480, UL2043, CSA C22.2 60065
 - h. Speakers grills shall be painted to match wall surface finish as required (if other than white). Coordinate finish with Architect prior to ordering.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install equipment and cabling to comply with manufacturers written instructions.
- B. Contractor shall provide equipment with manufacture's rack mounting equipment. Should the manufacture not provide rack mounting equipment, contractor shall mount equipment on DIN rails, blank panels, rack shelves or other means and methods to provide a securely mounted and neatly dressed installation.
- C. Provide plenum-rated twisted pair cable.
- D. All system cabling shall be neatly installed in cable tray. Cable tray provided by others as part of the project is as indicated on the drawings. Additional cable tray or cable containment, if required shall be provided and installed as part of the Public Address / Overhead Paging system.
- E. All cabling in exposed areas shall be run in conduits and shall be provided and installed as part of the Public Address / (Overhead) Paging System.
- F. Separate cabling and conductors by at least 12 inches from adjacent parallel power and telephone wiring.

- G. Make splices taps and terminations on numbered terminal strips in junction, pull and outlet boxes, terminal cabinets and equipment enclosures.
- H. Apply cable marking to designate media in coordination with system wiring diagrams.

3.02 COORDINATION

- A. This Contract involves coordination with the Phone System and the Data Network. Coordination with the Owner is critical. Do not interrupt any functioning system. Contractor shall give the Owner at least 7 calendar days notice of any requirement to shut off or interfere with existing alarm, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. All work such as splicing, connections, etc., necessary to establish or re-establish any system shall be completed by Contractor in close coordination with the Owner.
- B. Contractor shall coordinate complete functionality between the phone system and the paging system.
- C. Coordinate the work with the Owner and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
- D. Make sure work by others is scheduled in order that this work can be installed in a timely fashion.
- E. Verify all dimensions, and work by others that may be necessary to facilitate the work and coordinate with other trades. Assure that related work by others is coordinated with this work.
- F. Verify all field conditions. Regularly examine all construction and the work of others that may affect the work to ensure proper conditions are provided for the equipment and devices before their manufacture, fabrication or installation. Be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- G. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Coordinate with the Owner to assure that adequate electrical and HVAC, services are available. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.
- H. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner without additional expense.
- I. Interface Devices: Provide all items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.
- J. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- K. Installation shall comply with "Codes and Standards" section of this specification. Where more than one code or regulation is applicable, the more stringent shall apply.
- L. Install fire stopping for all penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to Owner.

- M. Verify the intended location(s) for equipment is suitable for the equipment. If any conditions such as temperature, humidity, dust level or the like require modification, make it known to the Owner immediately upon award of the contract. If any equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner immediately upon award of the Contract. Failure to notify the Owner of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.

3.03 SEISMIC PROTECTION

- A. Public Address System equipment shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The design of all seismic protection shall be performed by a Registered California Structural Engineer.
- B. The Contractor shall be responsible for the design of his own seismic restraint systems, and shall supply all seismic calculations and details to the Owner for review.
- C. Equipment shall be installed in accordance with the following guidelines:
 - 1. SMACNA Publication: Guidelines for Seismic Restraints of Mechanical Systems
 - 2. California Code of Regulations (CCR), Title 24, Division 22.
 - 3. NUSIG – National Uniform Seismic Installation Guidelines
- D. Contractor shall submit shop drawings for the mounting of equipment, fixtures, cabinets, consoles, conduit and cable support racks. These drawings shall be prepared, stamped and signed by a Registered California Structural Engineer.

3.04 INSTALLATION PRACTICES

- A. Verify that all conduits have been installed, de-burred and properly joined, routed and terminated prior to pulling of cables.
- B. Wiring must be run in conduit or in electrical trays, and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
- C. Equipment and devices shall be installed on approved electrical backboxes. Do not install equipment and devices directly on walls, ceilings or structural components without backboxes.
- D. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.
- E. In shared electrical trays, open ducts, and other cable runs without conduit, separate and strap Public Address cable so that it is clearly distinguishable from all other cables.
- F. Provide bushings, grommets and strain-relief for cables terminating at wall-mounted outlets and patch panels to ensure durable and robust connections. The bushings and grommets are intended to protect the cables from any sharp edges that present a risk to the cables. Ensure that all sharp edges are covered to protect the cables from damage.
- G. No cables shall be installed in a fashion that contravenes either the minimum installed or the minimum under-load bend radius of the cable.
- H. All cable shall run parallel or at right angles to building wall structures. Provide a support system for cable running in the ceiling void. Do not allow cable to rest on electrical or mechanical equipment. Do not tie cable to power or other foreign services. Support cable running in the vertical and horizontal direction in place at not more than 12" and 48" centers respectively.

- I. No cable is to be pulled through a conduit “L-bend” (condulets). In existing routes with L-bends, the cables are to be pulled to the L-Bend. The cable is then to be carefully pulled through the remainder of the conduit run.
- J. Install all cables in complete runs from end point to rack. In-line joints, splices, distribution points or other intermediate connections are not permitted unless specifically called out by this specification.
- K. At no point shall the cables be tied to power cables or other building services or their supports, or run in the same ducts, raceways, conduits or connection boxes as power cabling.
- L. Use plenum-rated tie wraps in plenum spaces.
- M. Reinstate all pull-wires in conduits and ducts after use to facilitate future addition of cables.
- N. Cables shall not be held so tightly with cable ties that the cable jackets are indented by the cable ties.
- O. Individually and properly ground all equipment cabinets, racks and ladder rack. Ground all metallic sheath communications cables entering the building per manufacturer specifications and NEC 770-33, 800-33 and 800-40.
- P. Ensure that all waste materials are disposed of in a safe manner. Pay particular attention to waste materials produced during the termination of optical fiber cabling. Ensure that all used components and fiber cut-offs are collected in purpose-made containers and disposed of properly.
- Q. Replace all moisture and fire barrier material in ducts, conduits and other penetrations disturbed during installation of communications cabling. Install barrier material in all fire-rated penetrations that have cabling running through them. The barrier material shall be installed so the final penetration has the same fire rating as the original wall/floor.
- R. Provide expansion plugs in all ducts/conduits entering the building. Seal all unused ducts/conduits with plugs that allow the pull-string to be tied off on the inside.
- S. Use purpose-built pulling grips during cable installation. Do not pull cables by attaching pull wires to cable jackets, elements or reinforcement. Use strain gauges or equivalent measures to ensure that the maximum tensile load rating of the cables is not exceeded during installation.
- T. The number of cables in each conduit shall be controlled to allow for future cable installation and to stay within the manufacturer’s maximum allowable cable pulling tension. Conduit fill ratios shall not exceed the current requirements of the NEC.
- U. Provide Velcro hook and loop ties to secure cabling running in the Telecom Closets. Provide straps at 3’ intervals. On completion of installation, neatly run and re-tie all cable bundles in the Closet.

3.05 LABELING

- A. Labels, tags or other permanent markings shall identify cables, wires, wiring forms, terminal blocks and terminals. The markings shall clearly indicate the function, source, or destination of all cabling, wiring and terminals. All cables and wires shall be identified, utilizing heat-shrink, machine-printed, labels. Note: Hand-written tags are not acceptable.

- B. All panels and rack-mounted equipment shall be provided with permanently attached engraved Lamacoid labels with identifying names and functions. Labels shall be consistent in form, color, and typeface throughout the system and all must contain the name of the system or subsystem as part of the label textual information. Design, color, font and layout shall be coordinated with, and approved by the Owner.

3.06 SYSTEM PERFORMANCE AND ACCEPTANCE TESTING

- A. Manufactures Field Inspection: Engage factory authorized service representative to inspect field assembled components and equipment installations, including connections and system programming. Prepare written report.
- B. System Programming: Fully describe the available programming options for Client selection. Prepare a written record of the Clients selected options and confirm implementation in writing.
- C. Operational Test: Demonstrate system by originating a page from each designated source location to each zone, zone combination, all call and all call priority groups. Verify routing, volume levels and freedom from noise and distortion. Frequency response test: Demonstrate a system performance with minimum frequency response 150Hz to 5000Hz (+/- 3dB).
- D. Distortion Test: Measure distortion at normal gain settings and rated power. Feed tones at frequencies between 150 Hz and 5000Hz into the system and record the output at the output of the paging amplifiers. Maximum acceptable distortion at any frequency shall be 2 percent total harmonic distortion. Maximum THD measured from input to output of any electronic component and gain stage shall be <0.1% at maximum continuous output.
- E. Acoustic output level and coverage uniformity test: Feed wideband (min. 100Hz to 5000Hz) pink noise into the system. Use a sound level meter to demonstrate continuous levels of not less than 98dB(A) +/- 3dB at 5' AFF throughout each shop zone and 80dB(A) +/- 3dB for each interior zone. System shall be engineered to provide a minimum 10dB of headroom at maximum output at every gain stage in the system.
- F. Use a sound level meter to measure ambient noise floors at peak and off- peak times. Adjust ambient noise sensor to provide paging SPL levels at 10dB above ambient noise up to the maximum SPL levels described in 3.06(E).
- G. Intelligibility test: Demonstrate a system performance with intelligibility not exceeding 15% ALCONS, and RASTI values not less than 0.45 throughout the covered areas.

3.07 OTHER WORK

- A. Cut and patch existing walls floors ceilings and other building finishes for installation. Repair, restore and refinish surfaces to original specification.

3.08 PHASED INSTALLATION

- A. Wherever phased installation is indicated in the project schedules, ensure that the system is fully operation at each stage of the phased installation, and compatible with the subsequent phases of installation.

END OF SECTION

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SECTION 27 51 26
ASSISTIVE LISTENING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. The work includes the provision of Assistive Listening Systems (ALS) as part of the building project.
- B. Portable ALS shall be provided to the Owner, where specified.
- C. Reference California Building Code (CBC) 2019 sections 11B-219 and 11B-706.
In addition the system shall comply with:
 - 1. 2010 Americans with Disabilities Act (Section 706)
 - 2. 2018 International Building Code (Section 1108.2)
- D. Scope of Work: The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional ALS. The instructions in this section are specific to the ALS installations and should be read in conjunction with other contract documents as applicable.
- E. Deliverables: Prior to ordering materials or commencing any construction activities, the contractor shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. ALS equipment to be manufactured by Listen Technologies or equal.
- B. Fixed/Permanent Systems: Provide one fixed system for each room with occupancy levels of 50 seats or greater as per ADA guidelines. Large Assembly Room #309.
- C. Wireless Networked Audio System: Provide one system in Large Assembly Room #309.
- D. Portable Systems: Provide a minimum of 3 complete portable systems for this building project (one per floor) with accessories as described below.
- E. Portable ALS Equipment

3. Provide the following Listen Technologies equipment for operation with the fixed voice reinforcement systems or portable systems as described below.
4. The transceiver and receivers shall be operating on a digital 1.9 GHz unlicensed PCS band utilizing Frequency-Hopping Spread Spectrum (FHSS) techniques allowing interference free one-way communication. The device shall employ a multiply layer security protocol consisting of a 40-bit (pin free) group subscription, 32-bit authentication and a 64-bit encryption scheme enabling secure conversations. It shall be easy to pair and form groups via Near-field communication (NFC), Docking Station or Software Suite. It shall be simple to operate with a Power and Volume Up and Down buttons. It shall allow up to 10 simultaneous groups to operate in the same area. It shall be powered via a removable non-proprietary rechargeable lithium-ion.
5. Transmitter/receiver set product – Listen Technologies ListenTALK #LKS-8-A1 including charging case.
6. 1 #LK-1 transmitter/transceiver and microphone and 3 #LKR-11 receiver units and headsets. Provide one additional #LKR-11 receiver unit for a total of 4 receivers as compliant with CBC.
7. Portable charging carrying case #LA-483 and one LA-423-01 4-port USB charger.
8. The receiver shall have 57 user-selectable, 72MHz FCC compliant, approved channels.
9. Provide for Each Portable Transmitter:
 - a. One #LA-365 Li-Ion Battery
 - b. One Headset with Boom Microphone #LA-451 or equal
 - c. Omni Conferencing Microphone #LA-277 or equal
 - d. One Line/Mic Y Cable #LA-263 or equal
10. Provide for Each Portable Receiver Pro:
 - e. One #LA-365 Li-Ion Battery
 - f. One Breakaway lanyard #LA-445-BK or equal
 - g. One Universal Ear Speaker #LA-401 or equal

F. Fixed ALS Equipment

11. Provide Listen Technologies digital FM equipment kit #LT-31-072-D for operation with the fixed voice reinforcement systems only as described below.
12. Base Station #LT-800-072-01 3-channel transmitter for fixed installations including the following with the additional accessories listed:
 - a. Twelve (2) total #LR-3200-072 intelligent digital receivers shall have 57 user-selectable, 72MHz FCC compliant, approved channels.
 - b. One (1) #LA423-01 4-port USB charger.
 - c. One (1) #LA-311 16-unit charging case.
 - d. One (1) Dante 1-channel output adapter.
13. The receiver shall have on/off, FM volume, Aux volume, Monitor volume, test tone on/off, Super Quiet Companding Technology on/off, Contour and channel up/down controls and an FM reception LED on the front panel. The front panel shall include a 2-digit channel LED display.
14. The receiver must have installer controls and ports on the back panel which include: antenna port; transmitter power settings; (2) mix outputs; (2) unbalanced audio inputs, selectable between +10 dBu and -10 dBu; (1) balanced XLR/¼” audio input, selectable between microphone, microphone with phantom power, and line level; and a separate DC jack to power the transmitter.

15. A minimum of 25% of all receivers (but no fewer than 2) shall be hearing aid compatible. Use neck-loop inductive lanyard #LA-430.
16. The channel display shall have an indicator light illuminated when the main power is off. The size of the receiver must be 20.3 (W) x 1.75 (H) x 20 (D) cm/8.0 (W) x 1.75 (H) x 8.0 (D) in. and weigh 1.4kg/3lbs.
17. The receiver must operate on 72MHz band, or other operating band approved by FCC for assistive listening devices.
18. Provide for Each Portable Receiver:
 - e. One #LA-365 Li-Ion Battery
 - f. One Breakaway lanyard #LA-445-BK or equal
 - g. One Universal Ear Speaker #LA-401 or equal
 - h. One Inductive Neck Loop #LA-430
19. Miscellaneous transmitter equipment to include the following:
 - i. Universal Transmitter Antenna – provide a standard or large area antenna as required to generate a signal to receivers located at any point in the instructional space covered by the dedicated transmitter. Listen #LA-122.

2.02 ACCESSORIES

- A. Provide (as required) in coordination with the project Architect, room signage for all locations supporting ALS for the building project.
- B. Provide for each Fixed system:
 20. Twelve-station charger #LA-381-01 with the following capabilities:
 - a. The charger must be capable of storing or recharging up to 12 transmitters or receivers at once.
 - b. The charger must have an external UL- and CSA-approved wall transformer that plugs directly into the charging unit itself. It must have a pocket to contain the power wall transformer during storage. There must be no on/off switch.
 - c. The charging circuitry must be fully automatic and be capable of recharging the transmitter/receiver batteries in 14 hours maximum when 500mA/Hr batteries are used.
 - d. The charger must be capable of recharging NiCad batteries without the need for removal of the batteries from the transmitter/receiver.
 - e. The charger must have a large, foam-lined storage space for accessories, a locking lid, and a handle.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Assistive Listening transmitters shall be provided to the Owner in the following rooms:
 21. Each room with 50 seats or more shall receive a fixed and installed ALS transmitter system.
 22. Each room with a sound reinforcement system shall receive a fixed and installed ALS transmitter system.

23. If multiple transmitters are specified within a facility, it is recommended that the adjacent transmitter channels be at least 300MHz apart. If no interference, the following channels are recommended; 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, 2L.
- B. Assistive Listening receivers shall be provided to the Owner as follows:
24. For sound reinforcing, per CBC Section 1104B.2, each room with 50 or more seats shall receive a quantity of ALS receivers that equals at least 4% of the number of seats in the room (rounding up to the nearest integer), but no less than two. (I.e. A classroom of 80 would receive 4 receivers.)
 25. Each portable system will be provided with 4 receivers.
- C. Fixed ALS transmitters will be located at AV Equipment rack positions dedicated to each room listed above, or where applicable in portable AV racks.
- D. Portable ALS transmitters and receivers will be given to the Owner for distribution.
- E. Equipment to be installed in accordance with manufacturer's instructions.

3.02 TESTING

- A. Following the installation of transmitters and antenna, each transmitter and receiver will be tested.
- B. Transmitters shall support signal distribution at all specified channels at any position in the instructional room to which its use is dedicated.
- C. Receivers shall be tested to verify function as specified by manufacturer.
- D. All transmitter/receiver sets will be tested simultaneously to ensure no channel conflicts occur.
- E. Each transmitter/receiver set will be labeled as to match each receiver to its base transmitter. Labeling shall include channel identifier.

END OF SECTION

SECTION 27 53 13
WIRELESS CLOCK SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Wireless Clocks

1.2 RELATED SECTIONS

- A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Division 27 15 00 Structured Cabling System

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
 - 2. Samples: Submit one clock for approval. Tag and install approved sample at location directed.
 - 3. Manufacturer's instructions: Submit complete installation, set-up and maintenance instructions.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- B. In addition, meet following:
 - 1. Warranty: Two year warranty on all components excluding batteries.
 - 2. Qualifications:
 - a. Installer: Company with documented experience in installation of commercial time systems.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

- A. Wireless clock system continually synchronizes clocks throughout facility and is capable of clock readouts in multiple time zones where desired.
- B. System synchronizes clocks to each other, utilizes GPS technology to provide atomic time and automatically adjusts for Daylight Saving Time.
- C. No hard wiring required except for Ethernet patch cable.
- D. Analog Clocks:
 - 1. Synchronized to within ten milliseconds multiple times per day.
 - 2. Internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy does not exceed plus or minus 0.2 second.
- E. System includes an internal clock reference so that failure of GPS signal does not cause clocks to fail in indicating time.
- F. System incorporates a "fail-safe" design so that failure of any component does not cause failure of system. Upon restoration of power or repair of failed component, system resumes normal operation without need to reset system or any component thereof.
- G. Clock locations as indicated and fully portable, capable of being relocated at any time.
- H. Furnish equipment and components of manufacturer's latest model.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Clocks
 - 1. American Time & Signal SiteSync IQ Wireless Clocks

2.2 CLOCKS

- A. American Time & Signal SiteSync IQ Wireless Clock:
 - 1. Hallway: Model Number: Double Side Hallway Clocks. (Battery Operated).
 - 2. Classroom: 12-inch Round Plastic Case – Surface Mounted with Battery Booster Temper Resistant Security Brackets

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Examination: Verify construction is complete in spaces to receive equipment and that rooms are clean and dry.
- B. Adjusting: Prior to final acceptance, inspect each clock, adjust as required and replace parts which are found defective.
- C. Cleaning: Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.
- D. System Startup: At completion of installation and prior to final acceptance, turn on equipment. Ensure that equipment is operating properly and clocks are functioning.
- E. Demonstration: Provide training to Owner on setting and adjusting clocks, replacing batteries and routine maintenance.
- F. Protection: Protect finished installation until final acceptance of project.

3.2 CLOCKS

- A. Reference 3.1, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

END OF SECTION

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DIVISION 28
ELECTRONIC SAFETY & SECURITY

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SECTION 28 00 00

SECURITY SYSTEMS BASIC REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes general administrative and procedural requirements for division 28 sections and supplements the requirements specified in Division 1.
- B. The requirements described herein include the following:
 - 1. References
 - 2. Definitions
 - 3. System Description and Existing Conditions
 - 4. Submittals
 - 5. Quality Assurance
 - 6. Permits and Inspections
 - 7. Coordination
 - 8. Project Management and Coordination Services
 - 9. Product Delivery, Storage, and Handling
 - 10. Warranty
 - 11. Maintenance
- C. Products Supplied But Not Installed Under This Section:
 - 1. None
- D. Products Installed But Not Supplied Under This Section:
 - 1. None
- E. Products Specified But Not Installed Under This Section:
 - 1. None
- F. Products Furnished and Installed Under another Section:
 - 1. 120V power
 - 2. Conduit, junction boxes, device boxes (essentially rough-in)
 - 3. Door hardware
- G. Related Sections:
 - 1. Consult other sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation.
 - 2. Section 280500, "Common Work Results for Electronic Security Systems"
 - 3. Section 280503, "Through Penetration Firestopping"
 - 4. Section 281300, "Access Control and Alarm Monitoring System"
 - 5. Section 282300, "Video Surveillance System"
 - 6. Division 27

7. Concrete Work: Include forming, steel bar reinforcing, cast-in- place concrete, finishing and grouting as required for underground conduit encasement, pedestal foundations, and curbs. [Also includes saw-cutting of existing slabs and grouting of conduits in saw-cut.]
8. Miscellaneous Metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, equipment enclosures, cameras, and similar devices.
9. Miscellaneous Lumber and Framing Work: Include wood grounds, nailers, blocking, fasteners, and anchorage for support of security materials and equipment. Refer to Division 6, Rough Carpentry.
10. Moisture Protection and Smoke Barrier Penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. Tape and make vapor tight penetrations through vapor barriers at slabs on grade.
11. Division 8 Locking Hardware: Include interface to electronic hardware and door controllers on security related doors.
12. Access Panels and Doors: Required in walls, ceilings, and floors to provide access to security devices and equipment.
13. Painting: Include surface preparation, priming and finish coating as required for security cabinets, exposed conduit, pull and junction boxes, and devices where indicated as field painted in this Division.

1.02 REFERENCES

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.
 - B. Codes: Perform work executed under this section in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
 1. California Code of Regulations (CCR):
 - a. Title 24, "California Building Standards Code"
 - 1) Part 1, "California Building Standards Administrative Code"
 - 2) Part 2, Volumes 1 and 2, "California Building Code" (CBC)
 - 3) Part 3, "California Electrical Code" (CEC)
 - 4) Part 11, "California Green Building Standards Code" (CALGreen)
 2. National Fire Protection Agency (NFPA)
 - a. NFPA 70, "National Electrical Code" (NEC)
 - b. NFPA 75, "Protection Of Information Technology Equipment"
 - c. NFPA 262, "Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces", 2007
- (OSHA)
- Regulations (Standards - 29 CFR)
 - a. Part 1910, "Occupational Safety and Health Standards"
 - b. Part 1926, "Safety and Health Regulations for Construction"

4. Code of Federal Regulations (CFR) Title 47 “Telecommunication”, Chapter I “Federal Communications Commission (FCC)”: a. International Building Code
 5. Other applicable national, state, and local binding building and fire codes
- C. Standards: Perform work and furnish materials and equipment in accordance with the latest editions of the following standards as applicable:
1. Underwriter’s Laboratories (UL): Applicable listing and ratings.
 - a. UL 294, “Access Control System Units”
 - b. UL 1076, “Proprietary Burglar Alarm Units and Systems”
 - c. UL 2044, “Commercial Closed-Circuit Television Equipment”

1.03 DEFINITIONS

- A. The Definitions of Division 1 apply to the sections of Division 28.
- B. In addition to those Definitions of Division 1, the following list of terms as used in this specification defined as follows:
1. “ACAMS”: Access Control & Alarm Monitoring System
 2. “As directed”: As directed or instructed by Owner, or their authorized representative
 3. “Cabling”: A combination of cables, wire, cords, and connecting hardware [e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling]
 4. “Connect”: To install required patch cords, equipment cords, cross connect wire, etc. to complete an electrical or optical circuit
 5. “Engineer”: TBD
 6. “Furnish”: To purchase, procure, acquire, and deliver complete with related accessories
 7. “IDS”: intrusion detection system
 8. “Install”: To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to Owner, parts, items, or equipment supplied by Contractor or others. Complete installation and make ready for regular operation
 9. “Owner”: LACCD
 10. “Provide”: furnish and install
 11. “Security System”: the ACAMS, IDS, VSS, and Intercom systems collectively and integrated
 12. “SEC”: Security Equipment Enclosure
 13. “VSS”: video surveillance system

1.04 SYSTEM DESCRIPTION

- A. Overview
1. Security at the new facility consists of access control and alarm monitoring system (ACAMS) and video surveillance system (VSS). The ACAMS will automate opening and closing the buildings, control access through designated doors, and will restrict after-hours access to authorized cardholders.
 2. The new system will integrate with the Owner’s existing Security Systems over the Owner’s Network.
 3. Refer to individual sections for detailed description of systems.

B. Custom Device Requirements

1. General: Provide a high level of coordination services to ensure the proper installation and functioning of the security system. Coordinate the installation of the security system with other trades. This may include review of other trade's shop drawings, attendance at meetings, providing samples for mockup, and preparation & distribution of written documentation.

1.05 SUBMITTALS

- A. Submit required submittals in accordance with the requirements of section 013300 "Submittal Procedures".
- B. Required submittals include the following:
 1. Written detailed project description
 2. Project schedule as referenced in this section
 3. Product data sheets – clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded
 4. Estimated delivery lead times for products
 5. Voltage drop calculations demonstrating less than ten percent voltage loss to individual security devices
 6. Battery calculations showing backup support of security equipment and locks (except egress hardware with local power supplies) for 25 lock activations or 4 hours, whichever is greater.
- C. Complete submittals are comprised of shop drawings and product data sheets as detailed below and related sections (covering specific security systems). Incomplete or partial submittals will be rejected.
- D. Shop Drawings
 1. Shop drawings shall document Contractor's intent to execute the work and shall include the following:
 - a. Title sheet and index
 - b. Floor plans showing device locations, cable routing, and pathways
 - c. System block diagrams
 - d. Point-to-point wiring diagrams
 - e. Specific wiring details and device mounting/installation details
 - f. Schedules:
 - 1) Building/floor
 - 2) Unique device name/number
 - 3) Security controller/location
 - 4) Interfaces, interlocks
 - 5) IP address
 - 6) Master/substation intercom calling locations
 2. Upon award of contract, request CAD release forms from the architect so that electronic files may be released for Contractor's use. The architect will release floor plans with devices; The architect will not provide installation details and block diagrams (Contractor shall develop their own diagrams and details for the shop drawings submittal package).

- E. Format: Furnish submittal data in electronic copy including table of contents with each section bookmarked by specification section listing materials.
- F. Label each submittal with the specification section number and provide a cover letter or stamp stating that the submittal has been thoroughly reviewed by the Contractor and complies with the requirements of the contract documents. Failure to comply with this requirement will constitute grounds for rejection of the submittal.
- G. Resubmittals: Provide a cover letter with the resubmittal that lists the action taken and revisions made to each product submittal in response to submittal review comments. Failure to include this cover letter will constitute rejection of the resubmittal package and no review will occur.
- H. Drawings
 - 1. Prepare shop and as-built drawings using software compatible with Revit per project standard.
 - 2. Drawing requirements:
 - a. Sheet size: match the project's contract drawings size and use the project's title block
 - b. Text size: minimum 3/32 inches high when plotted at full size
 - c. Symbology: match the project's contract drawings symbols
 - d. Backgrounds: screen background information to allow pertinent drawing information to stand out.
 - e. Line Weights: Use appropriate line weights for devices, raceways, and text to stand out against background information.
 - f. Floor Plans: 1/8 inch scale floor and site plans showing the locations of devices and cable routing paths with cable types and quantity called out.
- I. Contractor Qualifications: Submit the following for review and comment at the beginning of the project.
 - 1. Resumes of the project manager, general foreman, and lead technician(s) indicating role, years of experience, product certifications and training, listing of similar projects the individual performed the role proposed for this project along with client contact information for each.
 - 2. Certification letters from manufacturers of major system components stating Contractor is an authorized reseller, installer, and extended warranty provider for the specified security systems.
- J. Samples
 - 1. Submit samples as required for proper coordination and installation of custom mounted equipment. Examples of samples that may be required include:
 - a. Screen shots showing graphical floor plan maps indicating:
 - 1) Active functional icons
 - 2) Secure areas/zones
 - b. Camera field of views
- K. Installation shall not begin until product data and shop drawings submittals have been approved by LACCD.

1.06 QUALITY ASSURANCE

- A. General

1. Provide new and unused materials, equipment, and parts comprising the units specified herein of current manufacturer and of highest grade.
 2. Only use products and applications listed in this Division on the project.
- B. Bid Discrepancies
1. In the event of discrepancies within the contract documents, notify Engineer within 5 days prior to the bid opening to allow the issuance of an addendum.
 2. If, in the event that time does not permit notification or clarification of discrepancies prior to the bid opening, the following applies: The drawings govern in matters of quantity, and the specifications govern in matters of quality. In the event of conflict within the drawings involving quantities, or within the specifications involving quantities, or within the specifications involving quality, the greater quantity and higher quality apply. Note such discrepancies and clarify in the bid. We will make no additional allowances because of errors, ambiguities, or omissions, which reasonably should have been discovered during the preparation of the bid.
- C. Substitutions
1. Shall be reviewed and approved by LACCD.
 2. Conform to the general requirements and procedure outlined in section 012500 "Substitution Procedures".
 3. Where products are noted as "or equal", a product of equivalent design, construction, and performance is considered. Include in the product data submittal: catalog cuts, product information, and pertinent test data required to substantiate that the product is in fact equivalent to that specified.
 4. Only one substitution allowed for each product specified. Do not provide substituted material, processes, or equipment without written authorization from Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by Engineer, are at the sole risk of Contractor.
 5. The burden of proof rest with Contractor that the substituted product is equivalent or better than the specified product. When Engineer accepts a substitution in writing, it is with the understanding that Contractor guarantees the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction according to contract documents. Approved substitutions do not relieve Contractor of responsibilities for the proper execution of the work, or from provisions of the Specifications.
 6. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the contract documents are used to establish standards of quality, utility and appearance. Materials, processes or equipment that, in the opinion of Engineer, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when "or equal" follows the manufacturers' names or model number(s).
 7. Whenever material, process or equipment is specified in accordance with a Federal specification, an ASTM standard, an ANSI specification, UL rating or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by Engineer, submit support test data to substantiate compliance at no additional cost.
 8. Pay expenses, without additional charge to Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on self, Subcontractor's or other Contractor's work.
- D. Electronic Control Systems Contractor Qualifications

1. A current, active, and valid and C7 or C10 license registered with the Contractors State License Board (CSLB)
 2. Minimum five years of experience in installation and service of access control, video surveillance, and intrusion detection systems
 3. Minimum five completed projects similar to scope and cost
 4. Evidence of technicians qualified for the work in the form of current manufacturer's training certification
- E. Materials
1. Provide new materials and equipment without defects.
 2. Provide only specified products and equipment, or products and equipment that have been approved in writing.
- F. Regulatory Requirements
1. Work and materials to conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Perform work under these specifications confirming to the most stringent of the applicable codes.
 2. Provide the quality identified within these specifications and drawings when codes, standards, regulations, etc. allow Work of lesser quality or extent. The contract documents address the minimum requirements for construction.
- G. Drawings
1. Layout: Follow the general layout shown on the contract drawings except where other work may conflict with the contract drawings.
 2. Accuracy: The contract drawings show a diagrammatic representation of the system within the constraints of the symbology applied.
 3. Detail: The contract drawings represent the design intent and do not represent the entire installation for the System. Contract drawings indicate the layout and location of control panels, devices (i.e. card readers, door locks and contacts, and duress stations) and other components. The contract drawings do not show conduits, wire and cabling between every system component, equipment, or device.
 4. Complete the details necessary for point-to-point design. This allows the Contractor to attain the design intent while applying their own means and methods.
- H. Role of Engineer
1. During the construction phase of the project, Engineer will work with Contractor to provide interpretation and clarification of project contract documents, process and reply to relevant Requests for Information (RFI), and act as an interface between Contractor and Owner.
 2. Owner has retained Engineer's services to observe the work for general compliance with the contract documents.
 3. In summary, Engineer will perform the following specific services during the design phase:
 - a. Review product submittals and shop drawings for general compliance with the contract drawings and specifications.
 - b. Review changes as they arise and confirm that the proposed solutions maintain the intended functionality of the system.
 - c. Interpret field problems for Owner and translate into understandable language.
 - d. Review the testing procedures to confirm compliance with industry-accepted practices.

1.07 PERMITS AND INSPECTIONS

- A. Obtain and pay for permits and inspections required for the work.
- B. Furnish materials and workmanship for this work in conformance with applicable legal and code requirements.
- C. Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of legal authority having jurisdiction.
- D. Obtain review from compliance officials responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with requirements of reference codes indicated herein.

1.08 PROJECT MANAGEMENT AND COORDINATION SERVICES

- A. Provide a project manager for the duration of the project to coordinate the security system work with other trades. Coordination services, procedures and documentation responsibility include at a minimum, the items listed in this section.
- B. Review of Shop Drawings prepared by Other Subcontractors:
 - 1. Obtain copies of shop drawings for equipment and systems provided by others that require connections or interface with the security system work. Thoroughly review those shop drawings to confirm compliance with the interface requirements.
 - 2. Document discrepancies or deviations:
 - a. Prepare memo summarizing the discrepancy.
 - b. Submit a copy of the specific shop drawing, indicating via cloud, the discrepancy.
 - 3. Prepare and maintain a shop drawing review log indicating the following information:
 - a. Shop drawing number and brief description of the system/material.
 - b. Date of your review.
 - c. Indication if follow-up coordination is required.
- C. Scheduling: Prepare work schedules for each floor indicating the following information:
 - 1. Submittals
 - 2. Cable Installation
 - 3. SEC Build Out
 - 4. Device Installation
 - 5. Programming
 - 6. Testing
 - 7. Training
 - 8. Other tasks included under the alternate work section of these specifications
- D. Job Conditions
 - 1. Protection: Keep conduits, junction boxes, outlet boxes and other openings closed to prevent entry of foreign matter. Cover equipment, devices, and apparatus to protect them against dirt, paint, water, chemical or mechanical damage, before and during construction period. Prior to final acceptance, restore to original condition fixture, apparatus or equipment damaged including restoration of damaged factory applied painted finishes. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.

2. Supervision: Personally, or through an authorized and competent representative, supervise the work from beginning to completion and, within reason, keep the same foreman and workmen on the project throughout the project duration.
- E. Weekly Status Reports: Prepare weekly status reports throughout the entire course of the project containing the following information:
1. Current / up to date 2-week look ahead schedule
 2. Progress during prior week
 3. Work expected to be completed during the upcoming week
 4. Delivery dates for equipment
 5. Coordination status for each device requiring coordination with other subcontractors
 6. Summary of the information owed to Contractor, who is responsible for providing the information, and due date for the information
- F. Weekly Meetings: Conduct or attend weekly coordination meetings with the electrical and other specialty subcontractors to coordinate the installation of the security systems.
- 1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING
- A. Delivery
1. Do not deliver security system components to the site until protected storage space is available.
 2. Replace equipment damaged during shipping and return to manufacturer at no cost to Owner.
- B. Storage
1. Store materials in a clean, dry, ventilated space free from temperature extremes. Storage outdoors covered by rainproof material (for example, a tarp) is not acceptable.
 2. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
 3. Provide heat where required to prevent condensation or temperature related damage.
- C. Handling
1. Handle in accordance with manufacturer's written instructions.
 2. Prevent internal component damage, breakage, denting and scoring. Do not install damaged equipment. Replace damaged equipment and return equipment to the manufacturer.
- 1.10 WARRANTY
- A. Provide the Security System as described in this specification with a one-year parts and service warranty at no additional cost to Owner.
- B. Include in the warranty package, at a minimum, the following:
1. Emergency maintenance service on regular working hour basis
 2. Service by factory trained and employed service representatives of system manufacturer
- C. Maintain regular service facilities and provide a qualified technician familiar with this work at the site within four hours of receipt of a notice of malfunction including weekends and holidays. Provide material, devices, equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by Owner, complete and operational within 24 hours after notification of a malfunction, at no additional cost.

- D. Conduct warranty repairs and service at the job site unless in violation of manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts and personnel to and from the job site at no additional cost.
- E. Warranty period shall commence upon written final acceptance by Owner or Owner's designated representative.

1.11 MAINTENANCE

A. Extra Materials

- 1. Deliver extra materials to a secured location determined by Owner.
- 2. Provide a complete bill of materials listing quantities, part numbers, and descriptions for each device for Owner to sign indicating receipt of equipment.
- 3. Provide new and unused spare parts in their original packing materials upon delivery.

B. Maintenance Service

- 1. For the first year of service, conduct quarterly system performance review meetings to review system operation problems and/or defects that occurred during the preceding 3 months. During these performance review meetings, perform the following:
 - a. Visual checks and operational tests of the central processor, local processors, monitors, keyboards, system printers, peripheral equipment, security equipment and devices, power supplies, and electrical and mechanical controls.
 - b. Clean system equipment, including interior and exterior surfaces.
 - c. Perform diagnostics on equipment.
 - d. Check and calibrate each device.
 - e. Run system software and correct diagnosed problems.
 - f. Resolve previous outstanding problems.
- 2. Provide software and firmware updates issued free of charge by the manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

- A. Material and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the included systems. Where a particular material, device, equipment or system is specified directly, the current manufacturer's specification for same is a part of these specifications, as if completely elaborated herein.
- B. Use standard, regularly manufactured, materials and equipment for this and/or other similar systems, and not custom designed especially for this project. Provide systems and components thoroughly tested and proven in actual use. Provide subsystems of one manufacturer.

2.02 EQUIPMENT ENCLOSURES AND JUNCTION ENCLOSURES

- A. Application: For indoor use to house panels and equipment, and to house terminations, relays, and other components local to controlled doors and other field devices
- B. Type: NEMA type 1 enclosure
- C. Description:
 - 1. Solid steel enclosure with solid, continuous-hinged door
 - 2. Finish: ANSI 61 gray polyester powder paint finish inside and out

3. Lockable / equipped with a lock kit (lock kits shall be keyed alike with other security enclosures throughout the project)
4. Perforated back panel within enclosure (for mounting control boards, relays, terminal strips, etc.)
5. One tamper switch per enclosure
Manufacturer, or equal:
 1. Eaton Cooper B-Line
 - a. #36246-1PP; 36"L x 24"W x 6"D enclosure with back panel and lock kit
 - b. #12126-1PP; 12"L x 12"W x 6"D enclosure with back panel and lock kit
 2. Hoffman
 - a. #A36N24M; 36"L x 24"W x 6"D enclosure
 - b. #A36N24MPP back panel for 36" x 24" enclosure
 - c. #A12N126; 12"L x 12"W x 6"D enclosure
 - d. #A12N12PP; back panel for 12" x 12" enclosure
 - e. #AL12AR; lock kit
 3. Wiegmann
 4. SquareD

2.03 SLOTTED WIRING DUCT

- A. For indoor use inside equipment enclosures to manage/mind wiring.
- B. Description:
 1. Type: Lead-free PVC with narrow finger design
 2. Color: Light gray
- C. Manufacturer, or equal:
 1. Panduit Type-F narrow slot wiring duct
 2. Iboco #T1-1010 wiring duct

2.04 WIREWAYS

- A. For indoor use with equipment enclosures to manage and route wiring and cabling.
- B. Type: NEMA type 1 screw cover 'gutter' wireway and accessories
- C. Description:
 1. Wireways shall have open top assembly and closure plates/end caps (to secure end of wireway sections).
 2. Finish: ANSI 61 gray polyester powder paint finish inside and out
 3. Size: 4" x 4", minimum
- D. Manufacturer, or equal:
 1. Eaton Cooper B-Line #4448-G-NK; lay-in painted wireway without knockouts
 2. Hoffman #F44T148GVP lay-in painted wireway without knockouts

2.05 INTERFACE RELAYS

- A. Application: lock power switching and interfacing with other high-voltage powered equipment, i.e. gates, high-voltage locks, etc. (not for use at the output contacts on the access controllers since their rating is not adequate)

- B. Type: Standard industry control, plug-in type with LED indicator lights to indicate when the relay is energized.
- C. Contacts: Rated for 10 amps at 120VAC.
- D. Coil Operating Voltage: as required, with 24VDC as first choice
- E. Features:
 - 1. Color-coded test button
 - 2. Mechanical flag
 - 3. Snap-on label
 - 4. Pilot light
 - 5. 2mm test jacks
 - 6. Dual contact markings
 - 7. Snap-on number and letter markers
 - 8. Solid bus-bar socket construction
- F. Relay bases shall be mountable on standard mounting rails
- G. Manufacturer, or equal:
 - 1. Releco
 - 2. Idec

2.06 TAMPER RESISTANT HARDWARE

- A. Tamperproof hardware shall be used in locations below 10' exposed to the public.
- B. Hardware exposed in public spaces shall be pinned-allen type.
- C. Hardware used in specialty metal surfaces shall have a similar finish color.

2.07 WIRE CONNECTORS

- A. Wire connectors shall be heat activated; gel filled.
- B. Twist and solder/taped or wire nut connections are not acceptable.
- C. Manufacturer, or equal:
 - 1. Dolphin
 - 2. 3M Terminals
 - 3. Fastenal Sealed Crimp and Solder connector

PART 3 EXECUTION

3.01 EXAMINATION

- A. Conditions: Verify existing conditions, which have been previously provided under other sections, are acceptable for product installation in accordance with manufacturer's instructions.
- B. Pathways: Verify that pathways and supporting devices, which have been previously provided under other sections, are properly installed, and that temporary supports and devices have been removed.
- C. Field Measurements: Verify dimensions of pathways, including length of pathways. For example, "True Tape" the conduits to verify cable distances.

3.02 FIELD QUALITY CONTROL

- A. Staffing: Provide a qualified foreman who is in charge of the work and who is present at the job site at times work is being performed. Perform the work using skilled technicians under the direction of the foreman. Supervise the work force executing the work. Perform the installation within the restraints of the construction schedule. Do not change the supervisor during the project without prior written approval from Owner.
- B. Inspection: Perform inspection after installation. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection. Document completion, and inspection as required.

3.03 INSTALLATION

- A. Perform this work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.
- B. Provide a complete operating system. Include devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.
- C. System Password Management:
 - 1. Change default passwords.
 - 2. Create a base administrator account for Owner's use/login.
 - 3. Install the latest security patches (for the operating system and each individual piece of equipment).
 - 4. Disable unused communication ports or protocols.
 - 5. Perform quarterly software security patch updates for the client during the warranty period.
 - 6. Contractor to turn over all source media including installation discs, manuals, drives, dongles, and licensing keys and codes.
- D. Manufacturer's Instructions:
 - 1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
 - 2. Maintain jobsite file of Material Safety Data Sheets (MSDS) for each product delivered to jobsite.
- E. Boxes, Panels, and Enclosures
 - 1. Install boxes, panels, and enclosures square and plumb.
 - 2. Set flush-mounted units with the face of the cover, bezel, or escutcheon in the same plane as the surrounding finished surface.
 - 3. Mount boxes, panels, and trim so that there are no gaps, cracks, or obvious lines between the trim and the adjacent finished surface; ready them to receive final finish, as applicable.
 - 4. Install insulating terminations in signal circuit boxes, panels, wireways, or enclosures. F. Painting
 - 1. Custom paint devices as indicated on the drawings.

3.04 REPAIR/RESTORATION

- A. Replace or repair work completed by others that you deface or destroy, and at no cost to Owner.

- B. Punch List:
 - 1. Inspect installed work and develop a punch list for items needing correction.
 - 2. Submit punch list to Engineer for review prior to performing punch walk with Engineer.
- C. Re-Installation:
 - 1. Make changes to the system such that defects in workmanship are correct and cables and the associated termination hardware pass the minimum test requirements.
 - 2. Repair defects prior to system acceptance.
- D. Painting: Repaint surfaces altered during installation of the security system to match previous conditions.

3.05 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.
- C. Repair or replace damaged installed products.
- D. Legally dispose of debris in an environmentally friendly manner.
- E. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.

END OF SECTION

SECTION 28 04 09

BASIC SECURITY SYSTEM REQUIREMENTS CONSTRUCTION SPECIFICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional environment of electronic security systems. The instructions in this section are specific to security system installations and should be read in conjunction with other contract documents as applicable.
- B. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- C. Related Sections:
 - 1. Division 01 Section 010000 "General Requirements"
 - 2. Division 01 Section 013500 "Special Procedures"
 - 3. Division 07 Section 078413 "Penetration Firestopping"
 - 4. Division 08 Section 087100 "Door Hardware"
 - 5. Division 26 Section 260500 "Common Work Results for Electrical"
 - 6. Division 26 Section 260501 "Inspections and Testing of Electrical Work"
 - 7. Division 26 Section 260523 "Low-Voltage Electrical Power Conductors and Cable"
 - 8. Division 26 Section 260526 "Secondary Grounding for Electrical Systems"
 - 9. Division 26 Section 260533 "Electrical Conduit"
 - 10. Division 26 Section 260533.13 "Boxes for Electrical Systems"
- D. Where there are discrepancies between the drawings and the specification, herein, and related specification's sections, the Contractor shall be responsible to providing the more onerous solution.

1.02 DESCRIPTION

- A. General Description: This specification section covers general requirements for the furnishing, installation, and testing of a complete expansion to the Owner's electronic access control and video surveillance system.
- B. Furnish and install Electric Access Control System (EACS) software programming, hardware devices, mounting brackets, power supplies, switches, equipment cabinets, controls, consoles, and other components of the system as shown and specified.
- C. Furnish and install Video Surveillance System (VSS) software programming, hardware devices, mounting brackets, power supplies, video servers, Network Video Recorders (NVR), and equipment enclosures, as shown and specified.

- D. Furnish and install electrified locking hardware, special power supplies, door and frame modifications, and other components and services of the locking mechanisms as shown and specified.
- E. Furnish and install outlets, junction boxes, pull boxes, conduits, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26, Electrical Work.

1.03 QUALIFICATIONS

A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.
2. The manufacturer's products shall have been in satisfactory operation on at least three similar installations for not less than three years. The contractor shall submit a list of similar installations.
3. Components including, but not limited to, card access controllers, cameras, intercoms, computers, and power supplies shall have been tested and listed by Underwriters Laboratories, Inc., Factory Mutual Systems, or another approved independent testing laboratory.
4. Components installed within a common enclosure shall be approved by an agency recognized by the local city Department of Building and Safety as an assembly.

C. Contractor Qualifications

1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. The contractor shall submit copies of licenses to the Owner prior to the start of work.
2. Hold current legally required state registrations required to meet local requirements for submittal drawings.
3. Have manufacturers trained and certified engineering, field technicians and programming staff.
4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.04 GENERAL CONDITIONS

- A. Contract Compliance: Provide the Systems and Services in accordance with the conditions and system descriptions as described in Part 1 of each specification section. Provide specified or Owner-approved equivalent alternate products as described in Part 2 of each specification section. Utilize specified procedures and practices as described in Part 3 of each specification section.

- B. Codes: Furnish material and workmanship for this work in conformance with applicable legal and code requirements.
- C. Inclusive Work: Provide sufficient time, material and manpower to verify, revise or refine the Bid Drawings as necessary to develop fully engineered Shop Drawings as required by the General Requirements, and in order for this work to realize complete, stable and safe operation.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner and Architect requirements. Actual locations of visible components shall be coordinated in advance with the Owner and Architect.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.

3.02 SOFTWARE UPGRADES

- A. If more recent versions of the operating system or application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by the Contractor.
- B. Before installing upgrade software, the Contractor shall ensure that existing database information is properly "backed up" prior to any installation action.

3.03 PRELIMINARY INSPECTION, ACCEPTANCE TESTING, AND COMMISSIONING

- A. A. Provide Preliminary Testing, Inspection, Acceptance Testing, Burn-In, and Commissioning Performance services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.04 FINAL PROCEDURES

- A. Portable Equipment: Furnish portable equipment specified herein to the Owner, along with complete documentation for the materials furnished. Portable equipment shall be presented in the original manufacturer's packing, complete with manufacturer's instructions, manuals, and documents. Testing of portable equipment shall have been previously conducted by the Contractor.
- B. Post Acceptance Work: Check, inspect and adjust systems, equipment, devices, and components specified, programming updates, at the Owner's convenience, approximately sixty (60) days after Acceptance of the Installation.

3.05 NOTICE OF COMPLETION

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to the Contractor indicating the date of such completion. The Notice of Completion shall be recorded by the Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

END OF SECTION

SECTION 28 05 00

COMMON WORK RESULTS FOR ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work shall consist of the design, provision, termination, testing and documentation of a complete and fully functional environment of electronic security systems. The instructions in this section are specific to security system installations and should be read in conjunction with other contract documents as applicable.
- B. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- C. Related Sections:
 - 1. Division 01 Section 010000 "General Requirements"
 - 2. Division 01 Section 013500 "Special Procedures"
 - 3. Division 07 Section 078413 "Penetration Firestopping"
 - 4. Division 08 Section 087100 "Door Hardware"
 - 5. Division 26 Section 260500 "Common Work Results for Electrical"
 - 6. Division 26 Section 260501 "Inspections and Testing of Electrical Work"
 - 7. Division 26 Section 260523 "Low-Voltage Electrical Power Conductors and Cable"
 - 8. Division 26 Section 260526 "Secondary Grounding for Electrical Systems"
 - 9. Division 26 Section 260533 "Electrical Conduit"
 - 10. Division 26 Section 260533.13 "Boxes for Electrical Systems"
- D. Where there are discrepancies between the drawings and the specification, herein, and related specification's sections, Contractor shall be responsible to providing the more onerous solution.

1.2 DESCRIPTION

- A. General Description: This specification section covers general requirements for the furnishing, installation, and testing of a complete expansion to the Owner' electronic access control and video surveillance system.
- B. Furnish and install Electric Access Control System (EACS) software programming, hardware devices, mounting brackets, power supplies, switches, equipment cabinets, controls, consoles and other components of the system as shown and specified.
- C. Furnish and install Video Surveillance System (VSS) software programming, hardware devices, mounting brackets, power supplies, video servers, Network Video Recorders (NVR), and equipment enclosures, as shown and specified.

- D. Furnish and install electrified locking hardware, special power supplies, door and frame modifications, and other components and services of the locking mechanisms as shown and specified.
- E. Furnish and install outlets, junction boxes, pull boxes, conduit, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26, Electrical Work.

1.3 QUALIFICATIONS

A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.
2. The manufacturer's products shall have been in satisfactory operation on at least three similar installations for not less than three years. Contractor shall submit a list of similar installations.
3. Components including, but not limited to, card access controllers, cameras, intercoms, computers, and power supplies shall have been tested and listed by Underwriters Laboratories, Inc., Factory Mutual Systems, or another approved independent testing laboratory.
4. Components installed within a common enclosure shall be approved by an agency recognized by the local city Department of Building and Safety as an assembly.

C. Contractor Qualifications

1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to Owner prior to the start of work.
2. Hold current legally required state registrations required to meet local requirements for submittal drawings.
3. Have manufacturers trained and certified engineering, field technicians and programming staff.
4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.4 GENERAL CONDITIONS

- A. Contract Compliance: Provide the Systems and Services in accordance with the conditions and system descriptions as described in Part 1 of each specification section. Provide specified or Owner approved equivalent alternate products as described in Part 2 of each specification section. Utilize specified procedures and practices as described in Part 3 of each specification section.

- B. Codes: Furnish material and workmanship for this work in conformance with applicable legal and code requirements.
- C. Inclusive Work: Provide sufficient time, material and manpower to verify, revise or refine the Bid Drawings as necessary to develop fully engineered Shop Drawings as required by the General Requirements, and in order for this work to realize complete, stable and safe operation.

PART 2 - PRODUCTS

Not used. PART 3 - EXECUTION

3.1 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner and Architect requirements. Actual locations of visible components shall be coordinated in advance with Owner and Architect.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.

3.2 SOFTWARE UPGRADES

- A. If more recent versions of the operating system or application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by the Contractor.
- B. Before installing upgrade software, Contractor shall ensure that existing database information is properly "backed-up" prior to any installation action.

3.3 PRELIMINARY INSPECTION, ACCEPTANCE TESTING, AND COMMISSIONING

- A. Provide Preliminary Testing, Inspection, Acceptance Testing, Burn-In and Commissioning Performance services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.4 FINAL PROCEDURES

- A. Portable Equipment: Furnish portable equipment specified herein to the Owner, along with complete documentation for the materials furnished. Portable equipment shall be presented in the original manufacturer's packing, complete with manufacturer's instructions, manuals, and documents. Testing of portable equipment shall have been previously conducted by the Contractor.
- B. Post Acceptance Work: Check, inspect and adjust systems, equipment, devices, and components specified, programming updates, at the Owner's convenience, approximately sixty (60) days after Acceptance of the Installation.

3.5 NOTICE OF COMPLETION

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to the Contractor indicating the date of such completion. The Notice of Completion shall be recorded by Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

END OF SECTION

SECTION 28 05 03

THROUGH PENETRATION AND FIRESTOPPING

PART 1 - GENERAL

The standards provided have been set forth for the Contractor, installer to follow for any future projects and or renovations. For a complete list of material for each campus where work is performed, please refer to Build LACCD campus standards web site:

<http://www.buildlaccd.org/contractors-bidders/standards-guidelines/quick-search-results?type=guidelines&category=12>

These standards are provided to serve as a guideline for contraction project to be completed correctly per latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

1.1 SECTION INCLUDES

A. This section includes firestopping for through-penetrations and joints in or between the following fire-resistance rated assemblies, including both blank openings, linear openings, and openings containing penetrating items:

1. Floor-ceiling assemblies.
2. Roof-ceiling assemblies.
3. Walls and partitions.
4. Smoke barriers.
5. Construction enclosing compartmentalized areas.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

A. Underwriters Laboratories (UL) of Northbrook, IL "Fire Resistance Directory".

1. Through Penetration Firestop Systems (XHEZ)
2. Joint Systems (XHBN)
3. Perimeter Fire Containment Systems (XHDG)
4. Continuity Head-of-Wall Joint Systems (XHBO)

5. Fill, Void or Cavity Materials (XHHW)
 6. Firestop Devices (XHJI)
 7. Wall Opening Protective Materials (CLIV) B.
- B. All major building codes:
1. International Building Code published by ICC.
 2. (Note to specifier: Retain or delete the building codes listed above as applicable).
- C. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 101: Life Safety Code”.
- D. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 70: National Electrical Code”.
- E. Factory Mutual Approvals (FM) of Norwood, MA “FM 4991: Standard for Approval of Firestop Contractors”.
- F. Underwriters Laboratories (UL) of Northbrook, IL “UL Qualified Firestop Contractor Program”

1.4 PERFORMANCE REQUIREMENTS

- A. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
- B. When intumescent products are used, provide products that do not contain sodium silicate or any other water-soluble intumescent ingredient in the formulation. C. Provide firestop products that do not contain ethylene glycol.
- D. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
- E. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
- F. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur. Such devices shall be:
1. Capable of retrofit around existing cables
 2. Designed such that two or more devices can be ganged together
 3. Maintenance free such that no action is required to activate the smoke and fire sealing mechanism

- G. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with reenterable products specifically designed for retrofit.
- A. Subject to compliance with through-penetration firestop systems (XHEZ) and/or wall opening protective materials (CLIV) and/or joint systems (XHBN) and/or perimeter fire containment systems (XHDG) and/or continuity head-of-wall joint systems (XHBO) listed in Volume 2 of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
1. Acceptable Manufacturer: Specified Technologies Inc., 210 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.
 2. Hilti, Inc., Tulsa, Oklahoma 800-879-8000 www.us.hilti.com
 3. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.
 4. 3M Products
 5. Or approved equal

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. General: LACCD standards should be to provide Kit Style assembly system and putty style fire blocking materials where possible. Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.
- B. Intumescent Sealants: Single component intumescent latex formulations containing no water-soluble intumescent ingredients capable of expanding a minimum 8 times, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSS Intumescent Sealant
 2. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant
- C. Endothermic Sealants: Single component latex formulations that upon cure do not reemulsify during exposure to moisture, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant
- D. Elastomeric Sealants: Single component latex formulations that upon cure do not reemulsify during exposure to moisture and accommodate minimum ± 25 percent movement, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
 2. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant

- E. Firestop Devices: Factory-assembled steel collars lined with intumescent material capable of expanding a minimum 30 times sized to fit specific outside diameter of penetrating item, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSC Firestop Collars
 2. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars
- F. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings, the following products are acceptable:
1. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway
- G. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24" (610 mm), the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty Pads
 2. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads
- H. Firestop Putty: Intumescent, 100% solids, non-hardening, water resistant, butyl rubber based putties containing no solvents or silicone compounds, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty
- I. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film and capable of expanding a minimum 30 times, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series RED2 Wrap Strip
 2. Specified Technologies, Inc. (STI) SpecSeal Series BLU2 Wrap Strip
- J. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating on all six sides contained in a flame retardant poly bag, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSB Firestop Pillows
- K. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar

- L. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag), the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant
 2. Specified Technologies, Inc. (STI) SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant'
- M. All-Weather Coatings: Moisture curing, single component silicone copolymer elastomeric spray coatings for horizontal surfaces where greater water resistance is required or inclement weather is anticipated, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FT305 Firestop Spray
- N. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
1. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam
- O. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil capable of sustaining a minimum 2,500 lbs (1,134 kg) when subjected to load testing, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CS Composite Sheet
- P. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CD Cast-In Firestop Device
- Q. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FyreFlange Firestop Angles
- R. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material capable of expanding minimum 10 times with expansion beginning at 350°F (177°C) for use in blank openings and cable sleeves, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug
- S. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal T-Collar Device
- T. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing cable penetrations up to 0.53 in. (14 mm) diameter, the following products are acceptable:

1. Specified Technologies, Inc. (STI) EZ-Firestop Grommet (RFG1 or RFG2)
- U. Fire-Rated Closet Flange Gasket: Molded, single-component, intumescent gasket for use beneath a closet flange in floor applications, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series CF34 Closet Flange Firestop Gasket

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General Requirements: Install through-penetration firestop systems and fire-resistive joint systems in accordance with "Performance Criteria" Article and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.
 1. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
 2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of through-penetration firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
 3. Protect materials from damage on surfaces subjected to traffic.
 4. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.
 5. Where joint application is exposed to the elements, fire-resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C-920, "Specification for Elastomeric Joint Sealants".

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage. Contractor shall be responsible to provide visual inspection at end of project and shall be responsible to correct any deficiencies prior to owner's visual verification. Where repairs find enough repairs are needed, contractor shall make repair at no addition cost.

- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 28 05 28

SECURITY BUILDING PATHWAYS

PART 1 - GENERAL

The standards provided have been set forth for the Contractor, and installer to follow for any future projects and or renovations. For a complete list of material for each campus where work is performed, please refer to the Build LACCD campus standards website:

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These standards are provided to serve as a guideline for contractor projects to be completed correctly per the latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to the start of any project. After the contractor accepts any bid, the contractor shall be responsible for providing their work per the Set Standards.

1.1 SECTION INCLUDES

A. This section includes fire stopping for through-penetrations and joints in or between the following fire-resistance-rated assemblies, including both blank openings, linear openings, and openings containing penetrating items:

1. Floor-ceiling assemblies.
2. Roof-ceiling assemblies.
3. Walls and partitions.
4. Smoke barriers.
5. Construction enclosing compartmentalized areas.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. Underwriters Laboratories (UL) of Northbrook, IL "Fire Resistance Directory".
 1. Through Penetration Firestop Systems (XHEZ)
 2. Joint Systems (XHBN)
 3. Perimeter Fire Containment Systems (XHDG)

4. Continuity Head-of-Wall Joint Systems (XHBO)
 5. Fill, Void or Cavity Materials (XHHW)
 6. Firestop Devices (XHJI)
 7. Wall Opening Protective Materials (CLIV) B.
- B. All major building codes:
1. International Building Code published by ICC.
 2. (Note to specifier: Retain or delete the building codes listed above as applicable).
- C. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 101: Life Safety Code”.
- D. National Fire Protection Association (NFPA) of Quincy, MA “NFPA 70: National Electrical Code”.
- E. Factory Mutual Approvals (FM) of Norwood, MA “FM 4991: Standard for Approval of Firestop Contractors”.
- F. Underwriters Laboratories (UL) of Northbrook, IL “UL Qualified Firestop Contractor Program”

1.4 PERFORMANCE REQUIREMENTS

- A. Provide products that upon curing do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristics during and after construction.
- B. When intumescent products are used, provide products that do not contain sodium silicate or any other water-soluble intumescent ingredient in the formulation. C. Provide firestop products that do not contain ethylene glycol.
- D. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion, and other normal building movement without damage to the seal.
- E. Pipe insulation shall not be removed, cut away, or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
- F. Fire-rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons, and changes will occur. Such devices shall be:
1. Capable of retrofit around existing cables
 2. Designed such that two or more devices can be ganged together

3. Maintenance free such that no action is required to activate the smoke and fire sealing mechanism
- G. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with reenterable products specifically designed for retrofit.
- A. Subject to compliance with through-penetration firestop systems (XHEZ) and/or wall opening protective materials (CLIV) and/or joint systems (XHBN) and/or perimeter fire containment systems (XHDG) and/or continuity head-of-wall joint systems (XHBO) listed in Volume 2 of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
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 2. Hilti, Inc., Tulsa, Oklahoma 800-879-8000 www.us.hilti.com
 3. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.
 4. 3M Products
 5. Or approved equal

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. General: LACCD standards should be to provide Kit Style assembly system and putty style fire blocking materials where possible. Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.
- B. Intumescent Sealants: Single component intumescent latex formulations containing no water-soluble intumescent ingredients capable of expanding a minimum 8 times, the following products are acceptable:
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 2. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant
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 2. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant
- E. Firestop Devices: Factory-assembled steel collars lined with intumescent material capable of expanding a minimum 30 times sized to fit specific outside diameter of penetrating item, the following products are acceptable:
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 2. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars
- F. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings, the following products are acceptable:
1. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway
- G. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24" (610 mm), the following products are acceptable:
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 2. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads
- H. Firestop Putty: Intumescent, 100% solids, non-hardening, water resistant, butyl rubber based putties containing no solvents or silicone compounds, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty
- I. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film and capable of expanding a minimum 30 times, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series RED2 Wrap Strip
 2. Specified Technologies, Inc. (STI) SpecSeal Series BLU2 Wrap Strip
- J. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating on all six sides contained in a flame retardant poly bag, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series SSB Firestop Pillows
- K. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar, the following products are acceptable:

1. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar
- L. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag), the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant
 2. Specified Technologies, Inc. (STI) SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant'
- M. All-Weather Coatings: Moisture curing, single component silicone copolymer elastomeric spray coatings for horizontal surfaces where greater water resistance is required or inclement weather is anticipated, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FT305 Firestop Spray
- N. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam, the following products are acceptable:
1. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam
- O. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil capable of sustaining a minimum 2,500 lbs (1,134 kg) when subjected to load testing, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CS Composite Sheet
- P. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal CD Cast-In Firestop Device
- Q. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal FyreFlange Firestop Angles
- R. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material capable of expanding minimum 10 times with expansion beginning at 350°F (177°C) for use in blank openings and cable sleeves, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug
- S. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements, the following products are acceptable:
1. Specified Technologies, Inc. (STI) SpecSeal T-Collar Device

- T. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing cable penetrations up to 0.53 in. (14 mm) diameter, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) EZ-Firestop Grommet (RFG1 or RFG2)
- U. Fire-Rated Closet Flange Gasket: Molded, single-component, intumescent gasket for use beneath a closet flange in floor applications, the following products are acceptable:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series CF34 Closet Flange Firestop GasketPART

3 - EXECUTION

3.1 EXAMINATION

- A. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General Requirements: Install through-penetration firestop systems and fire-resistive joint systems in accordance with "Performance Criteria" Article and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.
 - 1. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
 - 2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of through-penetration firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
 - 3. Protect materials from damage on surfaces subjected to traffic.
 - 4. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.
 - 5. Where joint application is exposed to the elements, fire-resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C-920, "Specification for Elastomeric Joint Sealants".

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage. The contractor shall be responsible to provide a visual inspection at the end of a project and shall be responsible to correct any deficiencies prior to the owner's visual verification. Where repairs find enough repairs are needed, the contractor shall repair at no additional cost.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

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SECTION 28 10 00

ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Architectural Drawing Package, marked for Bid, and any current revisions noted by project management.
- C. Security systems drawings and other attached appendices and tables.

1.2 DEFINITIONS OF TERMS

- A. Owner: shall refer to Los Angeles Community College District (LACCD), and all its subsidiaries and affiliates
- B. Architect: shall refer to TBD.
- C. Security Consultant (ACS Consultant, Consultant): shall refer to Vantage Technology Consulting Group. Refer to "PART 1, SUBMITTALS" for any specific identification.
- D. Project/Construction Manager (CM): TBD
- E. General Contractor (GC): TBD
- F. Bidder: shall refer to any party proposing to provide the services and material delineated in this Specification.
- G. Bid: shall refer to a Bidder's proposal to provide the services and material delineated in this Specification.
- H. Integrator (Security Contractor, Integrator, Contractor): shall refer to the awarded contractor for this scope of services.
- I. ACS Specification (Specification): shall refer to the complete set of designs, performance and delivery requirements delineated within this document and all referenced documents.
- J. ACS System (Security System): shall refer to the complete complement of equipment, software, and other material that upon completion of assembly, installation and configuration provides the full functionality and technical performance delineated in this Specification.
- K. ACS Equipment (Security Equipment): shall refer to all individual equipment items and equipment items supplied by Division 281300 Contractor installed as a part of the Access Control System.
- L. Work: Design and provision the ACS and associated equipment, software, and services for the Project.
- M. Construction Documents: shall include all documentation associated with the design and general construction of the Project, including this Specification.
- N. Provide: Supply (furnish), deliver, install, test, configure, label, and commission.
- O. Manufacturer: shall refer to the original manufacturer of any equipment provided as part of the Work

- P. Commissioning Date: shall refer to the date at which a system is formally accepted by the Owner.
- Q. OFE: Owner Furnished Equipment.
- R. OFCI: Owner Furnished, Contractor Installed.
- S. CFCl: Contractor Furnished, Contractor Installed.

1.3 SCOPE/DESCRIPTION OF WORK

- A. The work covered in this Specification consists of furnishing all labor, material, and services to install a complete ACS system as indicated on the project documentation, including this specification and related drawings.
- B. Access control system shall be extension of existing Lenel On-Guard access control system. Contractor shall be responsible for providing card reader licenses, adding, and programming new door controllers, card readers, local alarms to existing access control server.
- C. The Security System includes integration to the Fire/Life Safety system to disconnect power to magnetic door holders, disable electronic locks at doors on the path of egress (see sheets LS10X for egress path of travel on each floor), and automatically close doors after hours.
- D. Door access control system to comply with CBC 2016 sections 1010.1.9.11, Exception 2 and 403.5.3, governing stairway operation, to this project. Interior egress stair doors at levels other than at the level of discharge have card readers from the stairway side to prevent unauthorized entrance to patient care and non-public service levels. These doors will be openable by staff with electronic key card and will also be unlocked upon fire alarm activation and will also be required to have fire fighter "bypass" mushroom button key switch located in level 1 lobby area next to fire alarm control panel.
- E. Door access control system to comply with CBC 2016 sections 1010.1.9.7 governing delayed egress door operation to this project. All delayed egress locking systems will be deactivated upon fire alarm activation or loss of power and will also be required to have "delayed egress deactivation" mushroom button key switch located in fire command center and approved locations per AHJ.
- F. Contractor shall be responsible for providing card reader licenses for all card readers in in the project.
- G. The work described in this Specification shall include, but not be limited to, the following Basic Services:
 - 1. Engineering and Design: The Integrator shall provide all system engineering and design necessary to develop the complete systems described herein. Engineering and Design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules, and lists.
 - 2. Procurement and Assembly: The Integrator shall procure and assemble all hardware and equipment and any additional materials as required to deliver completely functioning ACS.
 - 3. Software Programming: The Integrator shall perform all required software setup, configuration, and programming required to develop a complete operating system in accordance with this Specification, including all control logic and pushbutton component faceplate or interface programming.
 - 4. Installation: The Integrator shall install all equipment, cable, wiring, connectors, plates, and other material at the Project site per the Integrator's approved designs. The Integrator shall install any Owner Furnished Equipment identified in this document and calibrate it to work with the integrated systems.

5. Testing and Adjustment: The Integrator shall perform all tests and adjustments, furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this Specification and the Integrator's approved engineered designs.
6. Acceptance Testing: Prior to Owner acceptance and hand-over of the completed ACS, the Integrator shall demonstrate the operation of the complete systems, including all individual devices and specified control functions. Both subjective and objective tests may be required by the Owner to determine compliance with the information in this Specification and the Integrator's approved designs.
7. Training: The Integrator shall provide technical training of Owner's staff, instructing them on ACS operation, maintenance, and troubleshooting.
8. Warranty: The Integrator shall warranty the ACS in accordance with the terms of this Specification.
9. Specific Responsibilities:
 - a. Supply and install miscellaneous material, as necessary, to mount the ACS equipment.
10. Refer to "BID SUBMITTALS", Section 1.06 and "SUBMITTALS", Section 1.08. for additional information and requirements.

1.4 REGULATORY REQUIREMENTS

- A. All onsite labor must be in compliance with job-site union requirements.
- B. The Integrator must obtain any permits and shall pay all fees required by public agencies having jurisdiction over the Work.
- C. All products and materials provided shall be listed by Underwriters Laboratory (UL) and shall bear the UL label intended for the purpose specified and indicated. If UL has no published standards for a particular item, then other national independent testing standards shall apply, and such items shall bear those labels.
- D. All equipment and installations under this Specification shall conform to the latest editions of the following:
 1. NFPA 70 National Electrical Code.
 2. NFPA 72 – National Fire Alarm and Signaling Code
 3. IEEE C2 National Electrical Safety Code
 4. ANSI/TIA-568, -569 and -607 Telecommunications Standards
 5. IEEE 142 2007 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- E. The Integrator and its employees shall perform all work in compliance with current Occupational Safety and Health Administration (OSHA) guidelines and regulations and other safety and health requirements as may be mandated by the Owner, the General Contractor or other authorities.
- F. The Integrator shall have a thorough knowledge of governing codes and standards in effect and having jurisdiction over the Project. Lack of awareness of any of the relevant codes and standards will not be accepted as a reason for non-compliance.
- G. The Integrator shall be responsible for providing cable and materials that comply with applicable codes and requirements of regulating bodies. The cost for these materials shall be included in the Bid price, as the Owner shall not accept change orders for changes in materials.

1.5 COORDINATION OF RELATED WORK WITH OTHERS

- A. Related Work Specified Elsewhere: The Integrator shall coordinate with the General Contractor and other construction trades to ensure proper integration and operation of the ACS with the complete Project designs, building systems and all other elements of the Project. The Integrator should request from the Owner, General Contractor, or Architect complete project Construction Documents to help facilitate effective coordination of the Integrator's work with the work of others.
- B. Some components of the complete ACS will be provided by the GC, its sub-contractors, or the owner. It shall be the responsibility of the Integrator to coordinate with all parties whose work impacts the Integrator's work to ensure the complete coordination and successful implementation of the ACS. Related work by GC shall include, but may not be limited to, the following:
1. Electrical Work (Division 26):
 - a. Electrical (AC) Power Service and Connections:
 - 1) Technical Power Service: All electrical panels, power receptacles, lighting fixtures, dimmers, lighting controls, and interconnecting wiring shall be supplied by Electrical Contractor.
 - b. Low Voltage Cable Containment
 - 1) Low voltage cable containment, including raceways, conduits, and junction boxes, required to support ACS devices and interconnecting cabling shall be as specified in the Construction Documents and shall be provided by the Division 26 Contractor.
 - 2) Upon commencement of work on the Project, the Integrator shall review the Construction Documents to confirm that the infrastructure provided is sufficient to accommodate the ACS to be installed. Any conflicts or issues must immediately be brought to the attention of the Construction Manager or General Contractor, and the ACS Consultant.
 - 3) The Integrator shall provide blank cover plates or panels for all wall and ceiling boxes that are dedicated to the ACS but do not have devices and/or connectors at the time of ACS commissioning. Colors and types shall be coordinated with the Architect.
 2. Metals (Division 5)
 3. Rough Carpentry (061053)
 4. Joint Sealants (079200)
 5. Finishes (Division 9)
 6. Information Technology Systems: Unless otherwise specified, all data networking cabling shall be provided by Section 271300 and 271500 contractor(s) and the Owner. Unless otherwise specified, all active data networking electronics shall be provided by the Section 272000 contractor and the Owner. Patch cords to connect ACS equipment to a data network port shall be provided by the Integrator. The Integrator shall be responsible for coordinating with the Owner or the Owner's designated representative regarding connections between the ACS and the Owner's data network, including all client/server computing and peripherals, Internet, digital storage and other data/media distribution systems. Unless otherwise specified, equipment racks and cabinets, PDU's, and UPS's shall be provided by the Section 271100 contractor and/or the Owner. Coordinate with those entities to ensure space is available for any rack-mounted equipment.
 7. Other Systems: The Integrator shall be responsible for identifying and integrating with any other technology systems and services required to deliver the completely operating ACS.
 8. Equipment Mounting and Support:

- a. Structural support for ACS equipment shall be provided by General Contractor as noted and detailed in the Construction Documents. The Integrator shall coordinate with the General Contractor and other trades as necessary to ensure compatibility of the structural supports provided by others with the ACS Equipment provided by the Integrator.
 - b. The Integrator shall install all ACS Equipment, as indicated in this Specification and the Construction Documents. The Integrator shall verify location and structural suitability before attaching equipment and mounts. Any variations from the drawings and specifications or any question of structural integrity shall be brought to the attention of the General Contractor, Architect, and ACS Consultant before installing the equipment.
- C. Work Furnished by Others ("F.B.O.") but installed by the Contractor:
1. Owner Furnished Equipment (OFE): Some equipment that will become a part of or connect to the ACS may be provided by the Owner and shall be designated as Owner Furnished Equipment (OFE). Owner Furnished Equipment shall be supplied by the Owner to the Integrator for connection, installation and/or integration into the ACS as delineated in the construction documents and this Specification. This may include new or existing equipment. The Integrator shall be responsible for coordinating with the Owner's representative or Construction Manager to ensure that all Owner Furnished Equipment is fully operational and compatible with other ACS Equipment and that it is made available to the Integrator in a timeframe that does not delay the Integrator's work.

1.6 BID SUBMITTALS

- A. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors are not compensated for conditions that can be determined by examining documents or site and will not be relieved of any obligations with respect to bid.
- B. Questions: Submit all questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to all bidders as addenda and will become part of the Contract. The Architect and Owner may give, but will not be responsible for, oral clarifications. Questions received less than 10 days before bid date cannot be answered in writing.
- C. Equipment Availability: Verify with manufacturers' availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- D. Basis of Bids: To be eligible for Bid consideration, submit bids in accordance with the following:
 1. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for all specified items.
Itemization of miscellaneous equipment such as cable, switches, and receptacles are not required.
 2. Clearly indicate the total cost, including all expenses, for each individual system to allow the Owner to select any or all to be included in the contract. Itemization of miscellaneous equipment such as cable, switches, and receptacles are not required.
 - a. Access Control
 3. Organize each list with the information presented, in the order that it appears in this specification, in 6 columns from left to right:

- a. Paragraph number as it appears in this specification.
 - b. Paragraph title as it appears in this specification.
 - c. Manufacturer and model number.
 - d. Quantity.
 - e. Unit Cost.
 - f. Extension (unit cost times quantity).
4. At the end of each list indicate the cost of all other items such as for miscellaneous equipment, engineering, installation labor, overhead, taxes, etc.
 5. On a separate list indicate costs of any specified add- or deduct-alternates with the information presented in the same manner as for the base-bid system.
 6. Include a listing of any voluntary alternates proposed by the bidder as substitutions or additions to the specified systems.
 7. Include any notes or comments if necessary, to qualify the bid.
 8. Identify any sub-contractors and indicate the work they are to do.
 9. Provide documentation of ability in installing similar systems. Furnish the names, addresses and telephone numbers of the System Designer, Architect, General Contractor and Owner on three projects similar in scope, which the Contractor has installed within the last 5 years.
 10. Identify the proposed project management, engineering, and installation staff. Include resumes for each individual indicating relevant experience and certifications.
 11. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required, and the date of last calibration traceable to NIST, as applicable.
 - a. GENERAL CONTRACTING
 - 1) Multimeter.
 - 2) Cable Tester (Kopul CBT-MF or similar).
 - 3) Fiber-optic testing and field servicing equipment.
 - 4) Category 6 testing and field servicing equipment.
 12. Include certification of ownership and full familiarity with the operation of the following minimum software and analysis tools:
 - a. AutoCAD, version as required by the Owner (or .dwg compatible software, Stardraw not acceptable).
 - b. Revit, version as required by the Owner; or other BIM software, version as required by the Owner.
 13. BIDS NOT FULLY ITEMIZED OR NOT SUBMITTED IN THIS FORMAT WILL BE REJECTED. E. Delivery Schedule:
 1. Unless otherwise directed in Division 0, within 14 days of receipt of bid package provide:
 - a. Basis of bid documents, including:
 - 1) Itemized equipment costs for specified equipment or APPROVED substitutions.
 - 2) Qualifications/References
 - 3) Certifications (including certificate of bonding, if required) 4) Proposed payment terms.

1.7 QUALITY ASSURANCE

- A. Project Management: Maintain the same person in charge of work throughout installation. Engineering and construction supervisors shall be ESA CSI or approved equal.

- B. Contract Documents: always Maintain a complete set of system drawings and specifications at the site during installation.
- C. Fabrication and Installation: Fabricate all equipment enclosures and subassemblies, as required. Make field connections of control wiring, and control system circuits to equipment, equipment racks, and connection panels. Continuously supervise the installation and connections of cable and equipment.
- D. Contractor Qualifications: To be considered qualified for this work, bidders must meet the following standards:
 - 1. The Contracting firm is experienced in the provision of ACS similar in complexity to those required for this project.
 - 2. The Contractor's primary business is the provision, fabrication, and installation of professional ACS and related systems.
 - 3. The Contractor has been regularly engaged in the installation and service of professional ACS for a period of at least five years.
 - 4. The Contractor is an authorized dealer for the major products furnished.
 - 5. The proposed Project Engineer holds ESA CSSI certification or approved equal. The proposed installer holds ESA CVT certification or approved equal.
 - 6. The Contractor is certified by the manufacturer of the systems to install and configure all components of the system. The Contractor must assign a certified technician to conduct the work. Contractor must submit proof of certifications with the bid response.
 - 7. Additional certifications specific to project – manufacturer's certifications, etc.
 - 8. The Contractor is experienced in cloud-based control and management systems.
 - a. At the request of the Owner, Owner's representative, or Architect, demonstrate the following capabilities:
 - b. Adequate plant and equipment to complete the work in accordance with the project schedule.
 - c. Sufficient staff with appropriate technical experience to oversee and execute the work.

1.8 QUALITY ASSURANCE

- A. General:
 - 1. The Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Architect, that the proposed product is similar and equal to the named product.
- B. Documentation:
 - 1. File a formal request for each substitution, documenting the conditions outlined below, including:
 - a. Complete data on the proposed substitution, substantiating compliance with the ACS Contract Documents, including:
 - 1) Specification Section and description of the equipment or service originally specified by the ACS Consultant.
 - 2) Product manufacturer, model, and description of the proposed substitution
 - 3) Performance specification and test data verifying the proposed substitution's compliance with ACS and installation requirements.
 - 4) References and samples, where applicable
 - 5) An itemized comparison of the proposed substitution with the item originally selected in the ACS Specification.

- 6) The impact of the proposed substitution on the Contract time schedule, system design, artistic effect (for changes in finish or dimension), and related contracts and trades
2. Submit item comparisons, coordination schedules, and design impact via addenda appended to manufacturer documentation. C. Basis:
- 1. Requests for acceptance of proposed equivalents made following the award of bid are considered only in the following cases:
 - a. The named products cannot be obtained by the Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Contractor makes a written request for consideration of the proposed equivalent.
 - b. The proposed equivalent is approved as equal or superior to the named product and its use is to the advantage of the Owner. D. Consideration:
 - 1. A request for substitution is a representation by the Contractor that:
 - a. The Contractor has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - b. The same warranty is provided for the substitution as the original equipment specified.
 - c. The cost data presented is complete and includes all related costs under this Contract but excludes costs under separate contracts and excludes Architect's re-design costs, and that the Contractor waives all claims for additional costs related to the substitution which subsequently becomes apparent.
 - d. Any cost impact on work by other trades is indicated.
 - e. Installation of the accepted substitute will be coordinated by the Contractor, making such changes as may be required for the Work to be complete in all respects.
 - 2. An accepted substitution shall be documented by Change Order, effectively modifying the ACS Specification. The Contract Price will be changed only if the substitution results in cost savings to the Owner.

1.9 CONSTRUCTION SUBMITTALS

- A. Coordinate all submittals with requirements set forth in Section 013300.
- B. Bill of Materials & Manufacturer Product Data Sheets:
 - 1. Organize the Bill of Materials with the information presented in the order and format that appears in this specification.
 - 2. After the Bill of Materials, include Catalog Data Sheets ("cut" sheets) for all specified products arranged in the order listed in the Bill of Materials.
 - 3. Clearly indicate all finishes, colors and, options for equipment.
 - 4. As an alternative, provide product data sheets in electronic .pdf format, or another approved file format. Datasheets shall be organized in a logical manner, such as per system, to allow efficient review of the design documents. C. Shop Drawings:
 - 1. Size: minimum 24" x 36" unless otherwise specified.
 - 2. Media: provide in electronic .pdf file format unless otherwise specified or directed by the Construction Manager.
 - 3. Prepare a drawing package on the approved Computer Aided Drafting (CAD) or Building Information Modeling (BIM) system, including: a. Integrator name, address, and phone number.
 - b. Block diagrams indicating proposed connections of all equipment and indicating equipment brand and model numbers.
 - c. Equipment/ control room layout and equipment rack and cabinet details

- d. Provide detailed drawings of custom-fabricated or stock mounts and hardware.
 - e. Other drawings and sketches as required by the Architect or ACS Consultant during project installation.
4. Design drawing files provided by the Architect and/or ACS Consultant as a courtesy in aiding the Integrator in preparing Shop Drawings must be modified to include the information specified above. Submitting design drawings without these modifications is not acceptable.
- D. Data Network Connectivity
1. Any system, or components of a system, provided in this specification section which are to be connected to the Owner's data network either via wired or wireless connections will conform to the requirements described in PART 3 - EXECUTION. Vendors shall review the requirements of this section and provide a statement of compliance for each item that either:
 - a. Confirms that the proposed System (or any applicable components of the System) is compliant with the requirements listed in the item, or
 - b. Explains why the proposed System (or any applicable components of the System) is not compliant, including any potential mitigation measures that may resolve the non-compliance issue.
- E. Project Plan
1. Provide a complete and detailed Schedule for the Integrator's work describing the major tasks, sequence of work, submittals, and other critical milestones. At a minimum, the tasks noted in the Schedule shall include all required submittals, rack assembly, and shop testing, on site cable installation, periodic shop and site visits, on site equipment installation, testing and commissioning, Substantial Completion and Project Completion. Indicate the sequence of installation and completion by area and/or system. The Schedule shall also include anticipated dates of acquisition of major equipment and their installation milestones.
 2. Provide a complete listing of the Integrator's project team, including the names and all contact information (email address, cell phone, etc.) for all personnel assigned to the Project. At a minimum, this Project Team Directory shall include the Integrator's executive in charge of the Project as well as the Project Manager, Lead Engineer, and Lead Installer. Include names and contact information for all subcontractors.
- F. Weekly Status Reports
1. If directed by the Construction Manager, the Integrator shall provide weekly progress updates to the Architect and ACS Consultant. Weekly Status Reports shall be submitted as directed by the Construction Manager via faxed hard copy or electronic means (i.e., email). Issuance of Weekly Status Reports shall commence from the date of the first submittal delivery and shall continue until contract closeout.
 2. The Weekly Status Report shall not be used as an official means of communicating Project issues. It does not replace any part of a required submittal, request for information, proposed change order, report of field conditions, schedule issues, etc. No official response will be given to the Weekly Status Report.
 3. A representative of the Integrator shall attend the weekly construction meeting at the job site. This representative shall be fully knowledgeable in all aspects of the Project and the Integrator's work and shall have the authority to make binding commitments on behalf of the Integrator.
- G. SUBSTANTIAL COMPLETION SUBMITTALS

Substantial Completion of the ACS System installation shall be the point at which all ACS Equipment has been installed, programmed, configured, and initially tested to confirm proper operation. The point of Substantial Completion shall be as mutually agreed between the Integrator and the ACS Consultant following discussion and observation. At the point of agreed Substantial Completion, the Integrator shall submit the following:

1. Test Reports:
 - a. Upon completion of SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS specified in PART 3 - EXECUTION, submit for approval in writing test results including numerical values for all measurements.
 - b. Submit written certification that the installation conforms to specifications, is complete and operable, and is ready for FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION.
 - c. The Owner or Owner's representative reserves the right to withhold the final site visit "check-out" and any final certification of project completion until receipt of test report documents, as outlined in this section (SECTION 1 – "Test Reports").
2. Preliminary Project Record Documents Submittal
 - a. Upon Substantial Completion, the Integrator shall submit Preliminary Project Record Documents to the ACS Consultant. Preliminary Project Record documents shall be submitted prior to the Preliminary Checkout.
 - b. Preliminary Project Record Documents shall include:
 - 1) Corrected/updated shop drawings.
 - 2) Updated Equipment List
 - 3) Half-size drawings modified to reflect the actual installation conditions.
 - 4) USB Flash Drive or other approved media with manufacturers' operation manuals arranged alphabetically and current drawings in .DWG format.
 - c. ACS Consultant's Preliminary Checkout will be scheduled after the Preliminary Project Record Documents and Test Reports have been approved.

H. Manufacturer's Owner's Manuals:

1. Archive all Manufacturers' Owner's Manuals for specified equipment in the following manner:
 - a. One original (not photocopy) manufacturer's owner's manual per equipment item.
 - b. Submit in a 3-ring binder including a cover page and spine insert identifying the project, site location, and submittal.
 - c. Arrange manuals in alphabetical order, by manufacturer.
 - d. Provide a table of contents and separate each section within the binder with tab dividers.
 - e. If approved by the Owner, provide all Manufacturer's Owner's Manuals in electronic .pdf format on USB Flash Drive or other approved media. Owner's Manuals shall be organized in a logical manner such as per system and/or alphabetical order, by manufacturer. I. User Operational Manual:
1. Intent: Prepare in the form of a system operations manual for use by Owner's personnel. System documentation shall be adequate such that a person trained on the System, but with no familiarity with this specific implementation, shall be able to understand the configuration and implementation of all major and minor systems as well as how these systems are integrated to form the overall System.
2. Cover: Identify each volume with typed or printed titles "SYSTEM OPERATING INSTRUCTIONS".

3. Format: Submit the User Operational Manual in the following format:
 - a. Size: 8-1/2" x 11", 20 lb. minimum weight white paper for typed pages, either manufacturer's printed data, or neatly typewritten.
 - b. Drawings: Provide reinforced punched binder tab, bind in with text. Fold larger drawings to the size of text pages.
 - c. If approved by Owner, provide Operational Manual in electronic .pdf format on CD-ROM or other approved media.
4. Content of Manuals: Prepare the User Operational Manual with the following content:
 - a. Neatly typewritten table of contents for each volume arranged in systematic order. Identify each product-by-product name and other identifying symbols as set forth in Contract Documents.
 - b. Contractor name of responsible principal, address, and telephone number
 - c. Certificate of Warranty
 - d. Service Contract: Include a preliminary schedule for the specified semiannual site visits.
 - e. Complete as-built diagrams for systems.
 - f. Receptacle Location Plan
 - g. Shop drawings of all custom-fabricated items
 - h. Control Setting Schedule.
 - i. Documentation of all touch-panel screens both in the form of data files on CD-ROM, or other approved media, and graphical printouts.
 - j. ACS control system configuration files on USB Flash Drive, or other approved media, for the management and control system, or other software required for re-configuring the ACS management and control system.
 - J. System Diagrams:
 1. Provide sufficiently clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation, based on diagrammatic representations of the installed system.
 2. Provide drawings showing all terminal blocks, connectors, relays, switches, equipment, components, and wires.
 3. Provide layout drawings of panels and other custom assemblies containing switches, relays, terminal blocks, receptacles, etc., using reference numbers to identify physical locations of devices or label devices with reference numbers in a location visible while viewing cable terminations.
 4. On wiring diagrams, label all conductors within cables for insulation color or other identifier.
 5. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number.
 6. If device does not provide terminal designations, provide key diagram for reference.
 7. Label all devices with manufacturer, model number, and reference number (e.g., "SW 15", "TB 6"); reference numbers shall be consistent across all drawings with no repetitions.
 8. Provide labels for cables continued onto another drawing, indicating termination device, terminal numbers, and drawing sheet on which the termination is shown.
 9. Illustrate all receptacles, patch panel jacks, and switches.
 10. Receptacle Location Plan: Plan drawing of area showing locations and designations of all receptacles.
 - K. Forward all submittals to:
 1. The Project Manager, or as directed.

1.10 JOB CONDITIONS

- A. Sequencing and Scheduling:

1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
 2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
 3. Staff the job to keep pace with the other Trades; otherwise, the project manager will require an increase in force or overtime work without additional expenses to the Owner.
 4. Abide by the decision of the project manager in case of conflict or interference by other trades.
 5. Remove all refuse from the job site to the satisfaction of the Owner's representative.
- B. Do not install equipment in dusty conditions or allow dust to accumulate in or on installed ACS Equipment.
- C. Protect all work and equipment from damage by other subcontractors.
- D. Protect all existing work-in-place by other subcontractors from damage by the Integrator, the Integrator's agents and/or sub-contractors, or any employees or vendors. The Integrator will be solely responsible for any/all damage to work-in-place by other subcontractors.
- E. Keep areas around and inside of each piece of equipment and each rack free from dust, dirt, and debris throughout the project. Equipment that is not properly maintained during installation shall be replaced at no cost to the Owner before final payment is made to the Integrator.
- F. Storage and Staging:
1. The Contractor is ultimately responsible for acquiring secure storage at the job site. Coordinate with project management and/or Owner to determine the location and size of the storage area.
 2. All Integrator equipment and materials and all owner furnished equipment turned over to the Integrator stored at the Integrator's facility(s) or stored and/or installed at the Project site will remain the property of the Integrator unless ownership is legally transferred and accepted in writing by the Owner. The Integrator shall be solely responsible for the protection of all equipment from damage, theft, or vandalism regardless of cause, until the work described herein is accepted by the Owner at the time of Final Checkout.
- G. Refuse and Repair:
1. Upon completion of work remove all associated debris, waste, refuse, and rubbish from premises. Leave all areas and equipment within the scope of this contract clean, free of blemishes, and operational.
 2. Repair any damage to the premises, at no cost to the Owner, caused by the Contractor, its agents, and/or subcontractors.
- H. Adhere to the safety standards established by the General Contractor while performing work on site.
- I. All employees of the Integrator shall wear identification clearly indicating the Integrator's company name while on site.
- J. All employees of the Integrator shall comply with rules and policies established by the Owner and/or the General Contractor.
- K. All vehicles of the Integrator or employees shall be parked in areas designated by the Owner and/or the General Contractor.
- L. Environmental Impact Considerations
1. The Integrator is expected to comply with project specific practices and environmental considerations to comply with any LEED objectives and local environmental regulations.
 2. The Integrator is encouraged to utilize environmentally sustainable materials and work practices in the delivery of the Work. This may consist of (but not be limited to):
 - a. Energy Efficiency/Conservation

- b. Waste Reduction/Recycling
 - c. Water Conservation
 - d. Pollution Prevention
 - e. Employee Education Programs
 - f. Transportation Planning
 - g. Utilization of Renewable Materials
 - h. Minimize Emission of Greenhouse Gases
3. Upon request, the Integrator shall supply documentation on in-house policies for recycling and environmental offset goals. M. Promotion/Publication:
- 1. The contractor does not have the rights to use any information or images, relative to this contractor installation, for publication or in promotional materials without the express written permission of the Owner, Architect, and Vantage Technology Consulting Group. Upon approval, the contractor must disclose full credit to the Architect and Consultant for facilities and system design.
- N. Insurances on the work of this specialty trade shall be provided as specified in relevant project documentation.
- O. Inspection
- 1. Notify the Architect of any defects in work by other trades affecting installation.
- P. Packaging: Material and equipment manufacturers shall demonstrate efforts to reduce packaging waste and/or to use environmentally preferable packaging materials. Examples include, but are not limited to, the following:
- 1. Reusable and/or returnable pallets or crates
 - 2. FSC-certified wood or salvaged wood pallets or crates
 - 3. High recycled-content cardboard, paper, steel, or plastic packaging
 - 4. Bio-based foam packing materials.
- 1.11 DESCRIPTION OF SYSTEMS
- A. Functional Requirements of Systems
- 1. Access Control
 - a. Real-time access event monitoring
 - 1) Control and response, including acknowledge, clear, and annotate.
 - 2) Tracking and muster view/report generated by event or demand. 3) Guard tour by point or card read.
 - b. Manual override of system functions and schedules
 - 1) Door modes: Lockout, Lockdown, PIN Only, Card Only
 - c. Reporting
 - 1) Predefined or customized reports
 - 2) Event triggered Muster/Tracking report
 - 3) Schedule email of predefined reports 4) Export in HTML or delimited format
 - d. Elevator call and control
 - e. Anti-passback processing
 - 1) Hard or Soft per reader 2) Learn mode override.

- f. Dynamic floor plans
 - 1) Control access devices
 - 2) Floor plan linking
- g. Toggle lock during unlock schedule - lunch hour mode.
- h. Toggle lock outside of schedule - after hours meeting mode.
- i. Card database lookup
- j. User defined procedures per event/ schedule
- k. 3-Holiday types
- l. Prioritized Alarm Events
- m. Integrate access control with video Surveillance and intrusion systems.
- n. Arm or disarm per card read
 - 1) Record and playback access, intrusion or video events and alarms
 - 2) Define video presets per event.
 - 3) Alarm video popup and user verification
 - 4) Synchronized video playback with access, intrusion, or video events
 - 5) Define and extract video clips.
- o. Dynamic floor plans
 - 1) Control access, intrusion, and video devices
- p. Manual override of system functions and schedules
 - 1) Arm/disarm partitions and zone.
 - 2) Bypass/un-bypass zones

PART 2 PRODUCTS

2.1 ENGINEERING AND DESIGN

- A. Engineering and other pre-site services included in this Specification are considered furnished goods delivered to the site in a similar manner to physical materials. PART 2 of the ACS specifications is for review by the contractor's engineering department. The contractor is responsible for reviewing the specification and drawings and providing an ENGINEERED fixed-price quotation covering the cost of all equipment and labor to install, program, warranty, and service the systems described.
- B. The contractor is responsible for attending all pre-bid meetings and reviewing and understanding the systems design, functionality, and intent.
- C. The owner assumes that all contractors providing bid responses have included all the necessary equipment, parts, cabling, labor, engineering, programming, project management, testing and training costs, and will not approve any additional fees or costs, unless shown and approved to be beyond the scope of the specification and drawings.
- D. The equipment identified below provides examples of the level of quality and functionality required. These are predominantly major or unusual items and do not represent a complete list of equipment. The contractor is responsible for providing all equipment necessary for fully functioning turnkey systems.
- E. Where the equipment described includes "or approved equal", the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions to allow the owner or owner's representative to decide prior to bid submittal.

- F. Where the equipment described includes “or equal”, the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions as part of the product data submittal package delivered after award of contract.
- G. Where the equipment described does not include “or approved equal” or “or equal”, the contractor shall provide only the product specified. No substitutions will be accepted.

2.2 ACCESS CONTROL

A. Integrated Security Software:

1. Access control system shall be extension of existing Lenel On-Guard access control system. The contractor shall be responsible for providing card reader licenses, adding and programming new door controllers, card readers, local alarms to existing access control server. B. Door Controller:

1. Single Reader Interface Module: Lenel LNL-1300-S3
2. Dual Reader Interface Module: Lenel LNL-1320-S3
3. 16 Input Control Module: Lenel LNL-1100-S3
4. 16 Output Control Module: LNL-1200-S3
5. Compatible with specified card readers C. Intelligent System Controller:

1. Sized for number of door controllers and I/O modules located at the system controller, or as shown on the drawings.
2. Communications: Dual path onboard TCP/IP and RS-485.
3. OSDP (Open Supervised Device Protocol) for secure communications between Intelligent System controller and door controller.
4. Non-volatile storage of 50,000 events, minimum
5. 12 or 24 VDC input power
6. 32,000 access level permissions, maximum
7. 255 holidays, with grouping
8. Elevator control support 9. Alarm masking
10. Individual extended held open and strike times, per ADA.
11. 9-digit user PIN, max
12. Dedicated inputs for tamper and power failure status
13. TLS1.1 (with AES256 support) communication to the integrated security software.
14. Acceptable Products:
 - a. Lenel LNL-X4420 D.

Access Control Enclosures:

1. Provide and install high density enclosure.
2. All cables shall be run within an approved cable management system and shall be neatly dressed and labeled at the point of termination.
3. All labels shall be clearly visible without the need to remove any wire way covering or wire management device.
4. Furnish and install tamper switches on each access control panel enclosure. Tamper switches shall be wired to monitor points on the access control panel and shall be configured for twenty-four-hour alarm supervision.
5. Acceptable Products:
 - 1) LifeSafety Power
 - 2) Altronix

E. Door Hardware Power Supply:

- a. Applies to all integrated locksets and magnetic locks.
- b. 115 VAC input

- c. Dual-voltage output, 24 VDC/12VDC
- d. Amperage as required by lockset.
- e. Form C contacts for supervision
- f. Provide enough quantity of power supplies with factory-installed power distribution modules to permit simultaneous continuous-duty activation of all door locks with an additional minimum 20 percent capacity on each supply.
- g. Calculate voltage drop to locks and size lock control wiring to provide proper lock operation.
- h. Provide battery back-up enough for eight (8) hours standby plus twentyfive activations for all DC locks.
- i. Monitor the AC fail relay for power failure and the low battery relay for low battery. These alarms shall have individual monitor points on the access control system.
- j. Furnish and install tamper switches on each power supply enclosure. Tamper switches shall be wired to monitor points on the access control panel and shall be configured for twenty-four-hour alarm supervision.
- k. Provide and install cabinet locks on each power supply enclosure. Security Contractor to provide locks keyed alike for all power supply enclosures.
- l. UL 294 and 603 listed
- m. Acceptable Products:
 - 1) Lifesafety Power
 - 2) Altronix F. Card

Reader (Wall-Mount):

- 1. 125 kHz and 13.56MHz card reader
- 2. Bluetooth-BLE HID mobile access.
- 3. OSDP interface
- 4. 5" read range
- 5. 5-16 VDC input power
- 6. Two-piece, weatherproof design 7. Size of a 1-gang faceplate 8. Acceptable Products:
 - a. HID Signo Readers model 20 (Mullion mount), model 40 (single gang wall mount) readers.

G. Door Position Switch: Interlogix SPDT 1076/1078 series or approved equal. Coordinate finish with Architect. H. Request-to-Exit:

- 1. Request to exit sensors are integrated into electrified door hardware. Contractor to provide wiring to door hardware integrated request to exit devices.
 - 2. In some instances where integrated request to exit are not part of electrified door hardware provide dedicated Bosch DS160REX Series High Performance Request-to-Exit Detectors or approved equal. I. Local Door Alarm:
 - 1. Provide DSI Model ES4200-K0-T1 local alarm locations shown on the Drawings.
 - 2. Device shall include alarm sounder, alarm output for forced door connected to the Access Control System panel, and bypass output connected to the Access Control System.
 - 3. Configure an individual point on the Access Control System to monitor the bypass status of each local alarm. Configure an individual output on the Access Control System to remotely reset the door alarm and or bypass the door alarm.
 - 4. Provide Altronix AL300ULX 2.5 amp, 24VDC power supply, Altronix PD8ULCB, and 7Ah batteries in enclosure to power the local alarms.
- H. Lockdown button: STISS2475LD-EN

1. Lockdown button to be installed at all exterior entrances. Any door leading into a classroom. Refer to the room data sheets for more information.
2. Lockdown button to integrate with access control panel to override any door schedule to lockdown any card reader preventing any user access. Further coordination with LACCD is required.

2.3 GENERAL EQUIPMENT AND MISCELLANEOUS

A. Cabling, and Misc.

1. Use plenum-rated versions of the cables listed below in accordance with the NEC and all local codes.
2. Cables (Non-Plenum Applications):
 - a. Ethernet cable to PoE networked Door I/O controller.
 - 1) Windy City CAT6A UTP
 - b. Power (Electrified door lock):
 - 1) Twisted pairs, 18/2 AWG. 2) Windy City or equal.
 - c. OSDP Composite access control cable
 - 1) Windy City OSDP access control cable
 - d. RS-485:
 - 1) two twisted pairs with shield, 24 AWG, 120 ohms, 23 pF 2) Windy City or equal.
 - e. Alarm Input:
 - 1) Twisted pair, 30 ohms, max. 2) Windy City or equal.

PART 3 EXECUTION

3.1 GENERAL

- A. All types of equipment installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- B. All delivered equipment, except portable equipment, firmly fastened or held in place. Apply a minimum safety factor of four (4) times the load for all equipment fastenings and supports.
- C. Take necessary precautions to prevent and guard against electro-magnetic and electrostatic hum and to install the equipment to provide safety for the operator.
- D. Protect all equipment, including patch panels, connectors, receptacles, enclosure, and backup battery, from construction dust and debris until final acceptance of the system.

3.2 INTEGRATION/INSTALLATION

- A. Conformance to Existing Facility Standards
 1. Wherever possible provide equipment, finishes, and interfaces similar in nature to systems already in use by the Owner. Provide uniform functionality and

operation to enhance ease of use and minimize instruction. Provide uniform finishes and equipment to enhance the aesthetic unity of systems facility wide, and to improve end-user familiarity with equipment.

2. Equipment Integration:
 - a. New Equipment: Unless otherwise specified, supply only new equipment, parts, and materials, and protect all equipment from construction dust and debris until final acceptance.
 - b. Equipment Handling and Wear: Operate specified equipment only as required for testing, as part of the installation procedure.
 - c. Single Source: The provision of all manufactured components, installation, wiring, and testing is the responsibility of a single Contractor.
 - d. All equipment and installations under this Specification shall conform to the latest edition of the following:
 - 1) ANSI/NFPA 70 - National Electrical Code.
 - 2) ANSI/IEEE C2 - National Electrical Safety Code
 - 3) ANSI/TIA Standards 568, 569 and 607
 - 4) IEEE/ANSI 142-2007 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 5) Standard for Access Control Units
 - e. The Contractor shall not install any card reader, keypad, request-to-exit, or any other component located in exposed areas until a walkthrough has been scheduled for visual placement with final approval from the design team. The locations shown on the drawings are for reference purposes only, the Architect and Owner shall sign off on all final locations prior to the installation of the final devices with possible relocations based upon site conditions, these services shall be included in the contractor's base bid.
 - f. Equipment subject to public contact shall be installed with a torx head or equal security fasteners unless protected by a factory supplied cabinet lock.
 - g. Junction boxes, utility boxes, or other electrical enclosures housing system wiring not protected by factory supplied locks shall be installed with a torx head or equal security fastener.
 - h. Interior mounted equipment shall be installed after room finishes have been completed to protect the equipment from contamination.
3. Equipment Quantities:
 - a. Determine and provide the quantities of installed equipment based on the Bid Documents including the plans, functional diagrams, riser diagrams, and specification.
 - b. Quantities of portable equipment are indicated in schedules contained in the drawings or specifications.
4. Engineering and Documentation:
 - a. The system drawings indicate the general layout of the various items of equipment and their functional relationships. The layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item or parameter required for a complete installation.
 - b. The Contractor shall provide any incidental equipment needed to result in a complete and operable system even if not specified or shown on drawings without claim for additional payment.

B. Labels

1. Dry transfer, "Dymo", or other types of adhesive labels not acceptable
 2. Except where otherwise specified label as shown on drawings, and as specified, each item of rack-mounted equipment and all switches, controls, and receptacles.
 3. Switch and Control Panels: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness.
 4. Rack-Mounted Equipment: Labels constructed of engraved and filled plastic laminate engraving stock. Designate function and input and output line(s) or loudspeaker(s) served by labeled equipment. Key all designations to system functional and patch panel diagrams. Where possible, mount labels on blank panel directly above corresponding component. For modular equipment, provide label on inside of mainframe door identifying type of module for each slot (unless there is only one type) and gain setting as established at final checkout.
 5. Identification Panel: See drawings for layout and nomenclature. The contractor is responsible for completing all bracketed items with the appropriate projectspecific information.
 6. Branding and Recognition: Identification of the contractor or use of contractor logos or similar "trademarks" or "signatures" (including but not limited to touch panel graphics and color schemes, silk-screened or engraved corporate logos, copyrighted fonts, and/or custom emblazoned panels) is strictly forbidden except where explicitly indicated within the bid documents. Any unauthorized use of these marks will be rejected.
 7. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on drawings.
 8. Identify all wires and cables at every termination and connection point in accordance with the Owner's standards using the specified cable markers, unless otherwise instructed by the Owner. Use a numbering scheme that identifies all cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and C suffixes to distinguish multiple cables terminating at the same jack. Submit proposed numbering scheme for approval prior to installation.
 9. Identify switches, relays, terminal blocks, etc., with reference numbers keyed to the as-built wiring diagrams.
 10. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.
 11. All labels and legends shall be as approved on shop drawings.
- C. Racks, Cables, Connectors, and Miscellaneous Equipment
1. Wiring and Interconnections:
 - a. General:
 - 1) Exercise care in wiring to avoid damage to cables and equipment.
 - 2) Make all joints and connections with rosin-core solder or approved mechanical connectors.
 - 3) All wiring is executed in strict adherence to standard security practices. This includes:
 - a) Dress cables in conveniently sized bundles, combed into parallel runs, either laced or banded with sufficient plastic ties.
 - b) For equipment mounted on glides, or otherwise requiring servicing from the front of the rack incorporate a cable "service loop" of sufficient length to permit the equipment to be pulled forward from the rack for servicing.

- c) Support cables and bundles with sufficient plastic ties and support bars to ensure that no strain is placed on any connections or connectors.
 - d) Organize cables and cable bundles behind patch bays to permit easy access to the patch panels to add or remove cables.
- b. Grounding:
- 1) If not shown in drawings, ground case of power strip lines in equipment racks to the racks and directly to isolated ground buss in the power panel or to power system ground at the building AC service entry only.
 - 2) Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from ACS, including equipment racks.
 - 3) Insulate all conductors in conduit, including shields, from the conduit, back boxes, and from each other for the entire conduit length.
- c. Equipment Racks:
- 1) Install equipment in racks to permit access to all equipment for service. Relays, terminal blocks, etc., mounted in rear of racks behind other equipment shall not prevent access to equipment connections or shall be mounted on hinged panels to permit access.
 - 2) Where racks or cabinets are provided under this Section, wire all racks completely in the shop. No internal rack wiring is to be done on the job site.
 - 3) Install equipment in racks with ventilating panels as required to provide adequate ventilation and according to equipment manufacturer's recommendations.
 - 4) Where racks or cabinets are provided under this Section, provide unused panel space with blank or ventilating panels as shown on drawings.
 - 5) Locate free-standing racks as indicated and provide access to rear.
- d. Conduit:
- 1) Run all lines in metallic conduit or wireways unless otherwise indicated.
 - 2) Do not splice lines in conduit.
- e. Receptacles:
- 1) Provide a finished sample for approval by Architect.
 - 2) Wall-mounted receptacles in metal boxes at building standard receptacle height unless otherwise indicated.
- D. Wiring
- 1. Install systems wiring in accordance with the latest edition of local codes.
 - 2. Any miscellaneous Ethernet cabling required, but not installed under Division 27, must be installed in accordance with Division 27.
 - 3. Low voltage and coax cabling above access ceilings shall be grouped and supported every 3' (and within 6" of terminations) with clips intended for this use. Low voltage and coax cabling in new wall construction shall be run in EMT sized to no more than 40% fill capacity. Low voltage and coax cabling along interior existing walls shall be run in surface metal raceway. Minimize use of surface metal raceway by routing vertically into ceiling spaces.
 - 4. Label and color code wiring systems with labeling and coding shown on shop drawings.
 - a. Use white conductors only for neutral conductors and green only for grounding conductors.

- b. Group conductors within junction boxes, pull boxes and equipment enclosures and lace with nylon tie straps with identification tags in individual sets, serving individual locks or groups. Conductor group shall be identified on the tag with respect to room or area served.
 5. Standard wire shall be terminated with solderless, crimp-on, or insulated lugs properly sized for the gauge of wire and screw or push-on connection. The use of clamp type terminal connections is permitted. Pigtail and wire-nut connections are only permitted when equipment is supplied by the manufacturer in that manner as the only means of connection.
 6. Point-to-point wiring less than 1,000 feet shall be installed with no splices. If wire runs exceed 1,000 feet, splices are acceptable in accessible junction or pull boxes.
- E. Integrated Security Software (ISS)
1. Coordinate ISS workstation hardware requirements with Owner.
 2. Install the ISS software on an Owner-furnished computer.
 3. Add Users, configure the system, add devices and groups, configure event management, and create and add E-maps, as directed by the Owner.
 4. Integrate alarms with the building's e-call system, as required.
 5. Integrate the ISS with the video surveillance system using the video management system's API, if available.
 6. Provide copies of all configuration and support files to allow the Owner to reconfigure the system.

3.3 SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS

- A. Test all equipment to verify conformance with manufacturer's performance specifications and with this specification.
- B. At a minimum, the following items shall be verified:
- C. Cable Management, Termination, and Labeling Verification Item Numbers and Descriptions
 1. CABL-100 – Cable Bend Radius
 - a. Verify that cables are not bent beyond their minimum bend radius as specified in cable data sheet to maintain signal integrity as defined in the project documentation.
 2. CABL-101 –Connector Plate Input and Output Labeling
 - a. Verify that all ACS connector plate inputs and outputs are labeled as defined in the project documentation.
 3. CABL-102 –Connector Seating
 - a. Verify that all ACS connectors are correctly keyed, seated, and latched to respective connection points as defined in the project documentation. Conditions where physical parameters exceed the connector's ability to maintain full seating should be resolved as defined in the project documentation.
 4. CABL-103 –Connector Verification
 - a. Verify that all ACS cable terminations are made securely and meet the recommendations of the connector and cable manufacturer(s), published standards, and requirements defined in the project documentation.
 5. CABL-104 –Equipment Power Cable Management

- a. Verify that all ACS equipment power cables are managed as defined in the project documentation. Verify that cables are managed in a uniform and acceptable manner so as not to compromise safety/OEM warranty, ACS signal quality, and/or future field service.
6. CABL-105 – ACS Cable Labeling
 - a. Verify that all ACS cables are identified by a unique ID as defined in the project documentation. Verify that this unique ID is displayed permanently at both ends of the cable, is legible, and is positioned where it can be seen without undue disturbance.
7. CABL-106 – Cable Separation
 - a. Verify that both site and rack cables have appropriate separation according to signal type and level as defined in the project documentation.
8. CABL-107 – Cable Supports
 - a. Verify that all cables are supported throughout their lengths as defined in the project documentation.
9. CABL-108 – Cable Ties
 - a. Verify that, where appropriate, cable ties are used to secure the cables, are correctly tensioned, and that the correct type of cable tie(s) is used as defined in the project documentation.
10. CABL-109 – Cables Bundled by Type
 - a. Verify that cables are only bundled together when their construction, signal type, and signal level are compatible and will not cause measurable crosstalk or interference between cables.
11. CABL-110 – Cables Dressed
 - a. Verify that cables are dressed to ensure that all rack and site cables are installed to provide serviceability, safety, and aesthetics as defined in the project documentation.
12. CABL-111 – Patch Panel Configuration
 - a. Verify that all patch panels have been correctly wired and configured as defined in the project documentation.
13. CABL-112 – Patch Panel Labeling
 - a. Verify that all patch panels have been labeled as defined in the project documentation. Verify that all labeling is machine-printed, consistent, durable, accurate, and legible.
14. CABL-113 – Termination Stress
 - a. Verify that all cable terminations have been completed and adequately supported to minimize stress on the termination point and/or connector.
15. CABL-114 – Connector Plate Consistent Labeling
 - a. Verify that ACS connector plates have consistent labeling throughout the project as defined in the project documentation.
16. CABL-115 – ACS Cabling Verification
 - a. Verify that all cabling is the correct type and routed correctly from point to point as defined in the project documentation.

17. CABL-116 – Cable Length Required for Serviceability
 - a. Verify that sufficient cabling is available so the device can be placed in a serviceable location as defined in the project documentation.
- D. Control Performance Reference Verification Item Numbers and Descriptions
 1. CON-100 – Control System Communications
 - a. Verify that all control communications are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and functionality as defined in the project documentation.
 2. CON-101 – Interfacing and Control of External Devices and Systems
 - a. Verify that ACS control system interfaces to and from control systems provided by Division 281300 Contactor conform to requirements as defined in the project documentation.
 3. CON-102 – Mobile Device Integration
 - a. Verify that mobile devices that are to be supported are integrated and operating as defined in the project documentation.
 4. CON-103 – System Response to Event Condition(s)
 - a. Verify that any required response of the installed ACS in the event of a configured event operates as defined in the project documentation.
 5. CON-104 – Control System Automated Functions
 - a. Verify that all time-dependent or automated functions executed by the control system conform to requirements as defined in project documentation.
 6. CON-105 – Control System User Interface Performance
 - a. Verify that the control system is implemented in a manner consistent with the requirements as defined in the project documentation.
- E. System and Record Documentation Reference Verification Item Numbers and Descriptions
 1. DOC-100 – Final Inventory of ACS Equipment
 - a. Verify that all equipment has been delivered as defined in the project documentation.
 2. DOC-101 – Approval of Samples
 - a. Verify that samples of all equipment to be used as defined in the project documentation have been submitted for approval.
 3. DOC-102 – Delivered Product Against Samples
 - a. Where samples of products have been required for approval, verify that the products that are delivered are the same and of the same quality.
 4. DOC-104 – Consultant's Testing
 - a. Verify that any consultant's testing requirements defined in the project documentation have been performed and approved.
 5. DOC-105 – General Contractor's Testing
 - a. Verify that any general contractor's testing requirements defined in the project documentation have been performed and approved.

6. DOC-106 – Integrator’s Testing
 - a. Verify that any integrator’s testing requirements have been performed and approved as defined in the project documentation.
7. DOC-107 – Manufacturer’s Testing
 - a. Verify that any manufacturer’s testing requirements defined in the project documentation have been performed and approved.
8. DOC-108 – Owner’s Testing
 - a. Verify that any owner’s testing requirements defined in the project documentation have been performed and approved.
9. DOC-109 – Third-Party Testing
 - a. Verify that any third-party testing requirements have been performed and approved as defined in the project documentation.
10. DOC-110 – Substantial/Practical Completion
 - a. Verify that a conditional acceptance of the project has been issued by the owner or owner’s representative, acknowledging that the project or a designated portion is substantially/practically complete and ready for use by the owner, however some requirements and/or deliverables defined in the project documentation may not be complete.
11. DOC-111 – As-Built Drawings Complete
 - a. Verify that a complete set of accurate as-built drawings indicating all ACS devices, ACS device locations, mounting details, system wiring and cabling interconnects, and all other details has been provided as defined in the project documentation.
12. DOC-113 – Control System Test Reporting
 - a. Verify that the control system test report has been completed and issued as defined in the project documentation.
13. DOC-114 – Final Commissioning Report and System Turnover
 - a. Verify that the final commissioning report has been completed, issued to the proper entity, and accepted as defined in the project documentation.
14. DOC-115 – Required Closeout Documentation
 - a. Verify that a complete set of as-built system documentation has been provided as defined in the project documentation.
15. DOC-116 – Software Licensing
 - a. Verify that the usage and ownership rights have been assigned as defined in the project documentation.
16. DOC-117 – User Manuals
 - a. Verify that manufacturer’s user manuals are delivered to the owner in a format defined in the project documentation (e.g., binders, PDFs), or dispose of the manuals in a responsible manner (recycling) if the owner specifies that they do not wish to receive the manuals.
 - b. Integrator- or programmer-created manuals and documentation shall be delivered to the owner in a format defined in the project documentation.
17. DOC-119 – Warranties

- a. Verify that all warranties are activated and that all warranty details have been passed to the owner as defined in the project documentation.
18. DOC-120 – Final Acceptance
 - a. Verify that a final acceptance of the project has been issued by the owner or owner’s representative, acknowledging that the project is 100% complete, that all required deliverables, services, project-specific verification lists, testing, verification and signoffs have been received, and that all requirements defined in the project documentation have been satisfied and completed.
- F. Electrical Reference Verification Item Numbers and Descriptions
1. ELEC-100 – ACS Equipment Connected to Proper Circuit
 - a. Verify that all ACS equipment is powered from the designated power circuit and outlet as defined in the project documentation. No additional (non-ACS) equipment should be connected unless permitted in the project documentation.
 2. ELEC-101 – Grounding/Earthing
 - a. Verify that all elements of the ACS are correctly bonded to an electrical ground/earth in accordance with the requirements of the regulatory authority and as defined in the project documentation.
 3. ELEC-102 – Mains Voltage Sub-Distribution Integrity
 - a. Verify that all electrical sub-distribution systems provided by the Contractor in equipment racks, consoles, and similar structures meet local regulatory requirements for electrical integrity.
 4. ELEC-103 – Power Sources
 - a. Verify that the sources of mains voltage AC power to be used for the supply of ACS equipment are correct as defined in the project documentation and have been tested to the outlet in accordance with local electrical standards.
 5. ELEC-104 – Power Sequencing
 - a. Verify that the power sequencing of devices is correct as defined in the project documentation.
 6. ELEC-105 – UPS Operation
 - a. Verify that the uninterruptible power supply (UPS) is performing to the specifications as defined in the project documentation.
 7. ELEC-106 – DC Power Distribution
 - a. Verify that all DC powered devices are receiving the proper voltage and current for normal operation.
 8. ELEC-107 – Power Loss Recovery
 - a. Verify that the ACS resume normal operation on the restoration of power following a hard electrical power outage. Power loss recovery shall include verification of the resumption state on power recovery. Resumption state shall be the control system start-up condition/start page (where applicable) and resetting all devices to a known state as defined in the project documentation.
- G. Operations and Support Reference Verification Item Numbers and Descriptions
1. OP-100 – Software

- a. Verify that all control programming code, configuration files, and any other associated software have been provided as defined in the project documentation.
- H. Physical Environment Verification Item Numbers and Descriptions
- 1. PHYSE-101 – Human Factors, Usability, and Ergonomics
 - a. Verify that ergonomics and usability elements for system users are installed and configured as defined in the project documentation.
 - 2. PHYSE-104 – Backing/Blocking/Framing
 - a. Verify that installed backing, blocking, and framing meets project documentation requirements and industry standards for installation means and methods.
 - 3. PHYSE-105 – Clean Building Handover
 - a. Verify that the area is clean, free of dust, and suitable for equipment installation and that no further work is planned that will release contaminants into any ACS equipment area.
 - b. Verify that the area released is isolated from any areas not yet released.
 - 4. PHYSE-106 – Coordinated Construction Elements
 - a. Verify that the elements (including but not limited to spatial requirements and building services) required by the ACS that are coordinated with other disciplines have been provided as defined in the project documentation.
 - 5. PHYSE-107 – Device Enclosures
 - a. Verify that device enclosures accommodate the intended device and that all necessary environmental controls (e.g., heating, cooling, humidity) are incorporated into the enclosure as defined in the project documentation.
 - 6. PHYSE-108 – Finishes
 - a. Verify ACS equipment, furniture, fixtures, and accessories against the project documentation.
 - 7. PHYSE-109 –Wall Boxes/Ceiling Boxes
 - a. Verify that installed wall and ceiling boxes meet project documentation and regulatory authority requirements.
 - 8. PHYSE-112 – Structural Mounting
 - a. Verify configuration and compatibility of structural accommodations and all mounting hardware based on the intended application. All equipment mounting hardware shall be installed in the manner specified by the hardware manufacturer.
 - 9. PHYSE-113 – Protection of Installed Equipment
 - a. Verify that all elements of the ACS are free of damage.
 - 10. PHYSE-114 – Accessibility
 - a. Verify that all systems are accessible in accordance with regulatory requirements.
- I. Physical Installation Reference Verification Item Numbers and Descriptions
- 1. PHYSI-100 – Cable Containment/Conduit
 - a. Verify that installed containment/conduit capacity and routes meet project documentation requirements, industry standards, and regulatory requirements for installation means and methods.
 - b. Verify that installed containment/conduit is serviceable and free of contaminants.

2. PHYSI-102 – Equipment Security
 - a. Verify that equipment is secured as defined in the project documentation.
 - b. Verify that all security systems, devices, and manufacturer security accessories are installed and verified to be operating as defined in project documentation.
 - c. Verify that keyed devices have been keyed as defined in the project documentation and devices requiring configuration have been configured as defined in the project documentation and are verified to be operating within specification.
3. PHYSI-103 – ACS Equipment Labeling
 - a. Verify that all ACS equipment has been labeled in accordance with the requirements of the project documentation. All labeling must be consistent, durable, accurate, and visible without dismantling of sub-assemblies.
4. PHYSI-104 – Plumb and Level/Square
 - a. Verify that all ACS equipment has been installed, aligned, or angled correctly as defined in the project documentation. Level and plumb are the default requirement unless particular angles or other alignments are defined in the project documentation.
5. PHYSI-105 – Site Security
 - a. Verify that all elements of the ACS are free from loss, damage, or tampering.
6. PHYSI-106 – ACS Equipment Location
 - a. Verify that ACS equipment is installed at the location and/or in the rack or enclosure as defined in the project documentation. Equipment is installed per the elevation or other specification provided by the project documentation or the manufacturer's specification.
7. PHYSI-107 – ACS Rack Cleanliness
 - a. Verify that all components installed in ACS equipment racks are free from dirt, dust, water, or any other element that would compromise the performance and/or longevity of the ACS.
8. PHYSI-108 – Non-End-User Controls Protection
 - a. Verify that installed items with user-facing controls that are not intended for end-user access have been covered, disabled, or otherwise secured to prevent end-user operation.
9. PHYSI-110 – Handling of Accessories Otherwise Undefined
 - a. Verify that all items that are pre-packaged with primary system equipment but have no documented/planned use in the ACS(s) are managed in accordance with the project documentation.
10. PHYSI-111 – Turnover of Accessory System Elements
 - a. Verify that any equipment that may be considered portable and/or otherwise not specifically incorporated into the installed ACS(s) has been set up, configured, and tested.
 - b. Serviceability Reference Verification Item Numbers and Descriptions
11. SERV-100 – Access Panels
 - a. Verify that any access panels that have been installed to provide access to any type of ACS equipment are properly sized and positioned as detailed in the project documentation.

12. SERV-101 – Ability to Maintain and Service Equipment
 - a. Verify that all equipment is accessible and capable of being maintained, serviced, cleaned, or adjusted, as necessary.
 - b. Verify that all equipment requiring regular cleaning or maintenance is accessible without requirement for special equipment or tools that would disrupt the normal use of the facility and systems therein.
 13. SERV-102 – Input and Output Panel Accessibility
 - a. Verify that all input and output panels are accessible and meet all requirements for user access and placement.
 14. SERV-103 – Rack Clearance
 - a. Verify rack placement and use for physical stability in accordance with the project documentation and regulatory authority.
- J. Acknowledgement of Conformance to the Requirements

Acknowledgment of conformance to the Requirements shall include the following written statement, authored and signed by the system verifier, stating that all requirements of this Section have been completed, the date of completion, and that the handover of the completed, verified system is finalized.

“The system verifier acknowledges that the performance of this ACS has been verified in conformance with all required processes and contains all required elements as documented within this Section.

SYSTEM VERIFIER

DATE

3.4 FINAL ADJUSTMENTS AND ACCEPTANCE TESTS

- A. Upon approval of the contractor's test report, and at a time set by the Owner or Owner's authorized representative, perform final system adjustments and acceptance tests. Provide all labor, material, tools, and measurement equipment necessary for these tests and adjustments, including the test equipment and material specified, except as otherwise specified.
- B. The contractor's representatives performing these tests shall be thoroughly familiar with all details of the system and shall include the field supervisor in overall charge during the installation work.
- C. Budget eight (8) working hours for the performance of these tests and adjustments. If final acceptance is delayed beyond this period because of installation not in accordance with these specifications, pay for all additional time and expenses of Owner-designated observers during any resultant extension of the acceptance testing period. D. Adjustments: Adjust the system as instructed by the ACS Consultant.

3.5 TRAINING

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.
- C. After the completion of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS, provide on-site training to the end-user to instruct them on the proper use of each system, including:
 - 1. Explain operation of control systems and overall function of installed systems to staff selected by the Owner as "requiring general instruction".
 - 2. Explain operation of control systems, set-up, and operation of individual pieces of equipment, functions of overall systems, and rudimentary service guidelines to staff selected by the Owner as "requiring technician level instruction".
 - 3. If requested by the Owner, record these training sessions, and provide them to the Owner for future reference by the Owner's personnel.
 - 4. After successful training, a repair sequence (schedule of responsibility, response tree, etc.) should be established with any "technician level" staff, designated by the Owner as responsible for ACS operation and maintenance, to expedite service calls.
- D. Separate from the bid response quotation; provide an hourly cost for additional training.

3.6 WARRANTY

- A. Unless otherwise described in Division 01, provide for the warranty of the delivered system under the following terms and exclusions:
- B. Basic Warranty
 - 1. Basic Warranty provided by the Integrator shall include repair or replacement for one year from date of Final Acceptance on all ACS Equipment provided (including products having a manufacturer's warranty of less than one year) and all Integrator workmanship. Basic Warranty shall be provided at no additional cost, except in case of obvious abuse.
 - 2. During the Basic Warranty period the Integrator shall:
 - a. Provide telephone support within 4 hours of a call requesting service.
 - b. Provide emergency service: Within 24 hours of a call requesting service not corrected by telephone support, restore the system to operation, replace defective materials and repairing faulty workmanship. Make temporary repairs and provide loaner equipment at no charge if defective materials cannot be permanently replaced or repaired within this 24-hour period. Repair or replace faulty items within 72 hours of on-site service or within manufacturers' specific repair program whichever is quicker.
 - 3. Integrator shall not involve the Owner with removing, re-installing equipment, shipping, or receiving equipment being repaired under Basic Warranty, nor shall the Owner be responsible for any shipping or freight charges associated with any item under warranty.
 - 4. The Owner shall be copied with all paperwork related to all warranty work during the Basic Warranty period.
 - 5. The Basic Warranty period will commence no sooner than the date of first beneficial use by the Owner and no later than the date of contract closeout.
 - 6. Paint and exterior finishes, and batteries and other consumables excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
 - 7. The terms of individual equipment manufacturers' warranties are not diminished by the minimum warranty provisions specified above.

C. Preventative Maintenance

1. Within the term of the one-year Basic Warranty period the Integrator shall provide, at no additional cost, periodic Preventative Maintenance on the installed ACS to ensure proper ongoing maintenance and operation.
2. A minimum of four (4) Preventive Maintenance visits shall be provided.
3. Preventative Maintenance shall include, but not be limited to, the following:
 - a. Reviewing control system functionality
 - b. Any other maintenance and adjustments necessary to ensure that the ACS is in proper working order.
4. Any problems or issues noted by the users or other Owner representatives shall be documented and completely resolved at each of the scheduled visits.
5. Preventative Maintenance Schedule
 - a. 90 days (± 15 days) after the commencement of the Warranty Period.
 - b. 180 days (± 15 days) after the commencement of the Warranty Period.
 - c. 270 days (± 15 days) after the commencement of the Warranty Period.
 - d. 20 days (± 10 days) before the end of the Warranty Period.

D. Extended Warranty

1. The Integrator may elect to propose to the Owner the offer of Extended Warranty coverage for the ACS. Extended Warranty shall be any optional warranty services offered by the Integrator that expand on and complement the Basic Warranty coverage required by this Specification. Any provisions of Extended Warranty coverage shall not release the Integrator from responsibility for performance of all requirements under the Basic Warranty coverage.

E. Software Support

1. The Bidder shall also offer an annual Software Maintenance contract. This shall cover all software provided as part of this system and/or written for this system and shall include routine upgrades to applications and operating systems. The Software Maintenance contract shall commence immediately after expiration of the warranty period and continue for three years. Maintenance visits will be four times per year and shall be scheduled to coincide with the periodic system maintenance of the system.

END OF SECTION

SECTION 28 16 00
INTRUSION DETECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Intrusion detection system requirements.
- B. Alarm control panel.
- C. Keypads.
- D. Initiating devices.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 28 13 00 - Access Control: For interface with the intrusion detection system.
- B. Section 28 23 00 - Video Surveillance: For interface with the intrusion detection system.
- C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NFPA 70 - National Electrical Code.
- C. UL 609 - Local Burglar Alarm Units and Systems.
- D. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems.
- E. UL 639 - Intrusion-Detection Units.
- F. UL 1076 - Proprietary Burglar Alarm Units and Systems.
- G. UL 1610 - Central-Station Burglar-Alarm Units.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of devices for the installed locations with work provided under other sections or by others.
 - 2. Coordinate the placement of sensors and keypads with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 3. Coordinate the work with other installers to provide communication lines required for alarm control unit connection to central station.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents.
Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss intrusion detection system interface requirements.

- C. Sequencing:
 - 1. Do not install sensors and keypads until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
 - 1. Motion Detectors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- D. Design Data: Include standby battery calculations.
- E. Certify that proposed system design and components meet or exceed specified requirements.
- F. Evidence of qualifications for installer.
- G. Evidence of qualifications for maintenance contractor (if different entity from installer).
- H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- I. Manufacturer's detailed field-testing procedures.
- J. Field quality control test reports.
- K. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
- L. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in LACCD's name and registered with manufacturer.
- M. Maintenance contracts.
- N. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
- O. Software: One copy of software not resident in read-only memory.
- P. Maintenance Materials: Furnish the following for LACCD's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: Two for each type and size installed.
 - 3. Extra Initiating Devices: One for each type installed.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with intrusion detection systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized representative of control unit manufacturer.
Maintenance Contractor Qualifications: Same entity as installer.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products in the manufacturer's unopened packaging, keep them dry and protect them from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within the manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 77 00 - Closeout Procedures, for additional warranty requirements.
- B. Provide minimum two-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 - PRODUCTS

2.01 INTRUSION DETECTION SYSTEM REQUIREMENTS

- A. Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Arm/Disarm Keypads
 - 1. Placement:
 - a. In areas/zones requiring IDS sensors, but with undetermined regular monitoring hours for automatic arming/disarming.
- C. In areas/zones needing individual control of arming/disarming outside of scheduled monitoring times.
- D. Magnetic Contacts
 - 1. Placement:
 - a. All exterior building doors.
 - b. Any doors with controlled access via PACS.
 - c. Access hatches or doors leading to potentially hazardous areas lacking PACS or video surveillance coverage.
 - d. Ground floor operable windows allowing entry without using a door.

- E. Glass Break Sensors
 - 1. Placement:
 - a. Areas/zones housing highly valuable assets accessible from the building's exterior through glass breakage.
- F. Dual-Technology Motion Detectors
 - 1. Placement:
 - a. Areas/zones where privacy concerns prevent mounting video surveillance cameras but require motion detection.
 - b. Areas/zones with valuable assets benefiting from both cameras and dedicated motion sensors.
- G. Duress (Panic) Buttons
 - 1. Placement:
 - a. Areas/zones where significant cash amounts are handled.
 - b. Areas/zones used for disciplinary activities.
 - c. Offices of executive staff members.
- H. These placement guidelines ensure comprehensive coverage for the Intrusion Detection System (IDS) within LACCD facilities, enhancing security and response capabilities as per established standards and needs. Alarm Notification and Reporting Requirements:
 - a. Activate alarm notification at alarm control unit and associated keypads/annunciators with appropriate zone information displayed.
 - b. Transmit alarm report to LACCD Public Safety Office.
 - 1. Primary Communication Means: Digital cellular communications.
 - 2. Secondary Communication Means: Internet/intranet (IP addressing).
- I. All intrusion functionalities shall be monitored and controlled from within Alarm Monitoring in OnGuard. Interface with Access Control:
 - a. Provide products compatible with Lenel OnGuard requiring interface with intrusion detection system.
 - b. Interface with access control system as specified in Section 28 13 00.
 - 1. Capable of affecting access for designated doors for selected intrusion detection system events.
 - 2. Capable of affecting intrusion detection system status for selected access control system events.
 - 2. Interface with video surveillance system as specified in Section 28 23 00.
 - a. Capable of activating video surveillance system and controlling camera inputs/video outputs for selected intrusion detection system events.
 - 3. Interface with electrically operated door hardware as specified in Section 08 71 00.
 - a. Capable of locking/unlocking/releasing designated doors for selected intrusion detection system events.
- J. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - a. Local Alarm Units and Systems: Listed and labeled as complying with UL 609.
 - b. Central Station Alarm Units: Listed and labeled as complying with UL 1610.
 - c. Proprietary Alarm Units and Systems: Listed and labeled as complying with UL 1076.
- K. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.02 ALARM CONTROL UNIT

- A. Alarm Control Panel: Modular construction.
1. Manufacturer product to be Bosch.
 2. Enclosure: Lockable; provide tamper protection.
 3. Power Supply:
 - a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.
 - b. Secondary Power: Standby battery; provide suitable capacity for minimum standby time required by listing requirements, applicable codes, and authority having jurisdiction, but not less than four hours; provide suitable battery charger; supervised for low battery condition; protected from accidental reversal of battery leads.
- B. Alarm Initiating Circuits: Supervised.
1. Hardwired Zones: Supports both normally closed and normally open conventional (non-addressable) initiating devices.
 2. Addressable Zones: Supports addressable initiating devices and modules using multiplexed polling loops.
 3. Wireless Zones: Supports wireless devices using wireless receivers and repeaters.
 4. Minimum Number of Zones Supported: Equivalent to basis of design.
- C. Alarm Notification Circuits: Supervised.
- D. Communications Interfaces: Supervised.
1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:
 - a. Telephone lines.
 - b. Digital cellular network.
 - c. Internet/intranet (IP addressing).
 - d. Long-range radio (LRR).
 2. Supported Reporting Format(s): Compatible with central station.
 3. Supports split reporting.
- E. Keypads: Supervised.
1. Minimum Number of Keypads Supported: Equivalent to basis of design.
 - a. Bosch Keypad
- F. Peripheral Devices: Supervised; provide tamper protection.
- G. Output Relays:
1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
 2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.
- H. User Codes:
1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.
 2. Minimum Number of User Codes Supported: Equivalent to basis of design.
- I. Partitions:
1. Each partition to operate independently with individually programmable annunciation, control, and reporting functions.

2. Supports common partition shared by other assigned partitions.
 3. Each zone to be individually assignable to any partition.
 4. Each keypad to be individually assignable to any partition.
 5. Each output relay to be individually assignable to any partition.
 6. Each user code to be individually assignable to any partition.
 7. Minimum Number of Partitions Supported: Equivalent to basis of design.
- E. Scheduling:
1. Provide time/calendar-based scheduling capability for automated system control.
 2. Supports open/close schedules for control of arming/disarming and reporting.
 3. Supports timed events including, but not limited to:
 - a. Point bypass/unbypass.
 - b. Relay activate/deactivate.
 4. Supports automatic adjustment for daylight savings time.
 5. Supports holiday schedules.
- F. Event Log:
1. Stores system events including time, date, partition, zone, and user code where applicable.
 2. Supports viewing of event log on keypads.
 3. Supports viewing of event log on remote PC.
 4. Minimum Number of Events Stored: Equivalent to basis of design.
- G. Features:
1. Capable of being programmed locally or remotely.
 2. Capable of being armed via key switch.
 3. Supports panic/duress codes.
 4. Supports user interface via:
 - a. Telephone.
 - b. Web browser.
 - c. Mobile device.
 - d. Personal wireless device.

2.03 KEYPADS

- A. Manufacturer: Bosch.
- B. Provides interface to alarm control unit for system control and remote annunciation.
- C. Provides visual notification of system status and zone information.
- D. Provides audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.
- E. Keypad Type: LED, LCD, or graphic touch screen keypads are acceptable.
- F. Graphic Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.
- G. LCD Keypads: Displays system status and zone information using plain English on alphanumeric display; illuminated keys.

- H. LED Keypads: Displays system status and zone information using LED indicators; illuminated keys.
- I. Keypad Color: To be selected by Architect from manufacturer's available standard colors.

2.04 INITIATING DEVICES

- A. Manufacturers: Same as manufacturer of alarm control units where possible.
- B. General Requirements:
 - 1. Provide devices suitable for intended application and location to be installed.
 - 2. Outdoor Units: Weather resistant, suitable for outdoor use.
 - 3. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by control unit.
 - b. Provide suitable addressable modules for connection to conventional (nonaddressable) devices and other components that provide a dry closure output.
 - 4. Wireless Devices:
 - a. Reports sensor status to control panel via self-contained or separate accessory wireless transmitter.
 - b. Sends periodic check-in signals to control panel for reporting of missing devices.
 - c. Reports low battery condition before its battery becomes too discharged to power the transmitter.
 - d. Provide tamper protection.
- C. Contacts (Door):
 - 1. Manufacturer product to be GE 1078/1078CW
 - 2. Listed and labeled as complying with UL 634.
 - 3. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors or windows.
 - a. Use standard security contacts (not balanced magnetic type) unless otherwise indicated.
 - b. High Security Contacts: Balanced magnetic type; designed to activate upon attempts to defeat contact through external magnetic tampering.
 - 4. Contact Color: To be selected by Architect from manufacturer's available standard colors.
- D. Motion Detectors:
 - 1. Manufacturer product to be Bosch
 - 2. Listed and labeled as complying with UL 639.
 - 3. Dual Technology PIR/Microwave Motion Detectors: Designed to detect intruder using combination of passive infrared technology (by sensing movement of thermal energy between zones) and microwave technology (by sensing frequency shifts in emitted and reflected high frequency microwave signals).
- E. Glass Break Detectors:
 - 1. Manufacturer product to be Bosch.
 - 2. Listed and labeled as complying with UL 639.
 - 3. Suitable for the glass type to be monitored.
 - 4. Accurately discriminates false alarms from true glass break events.
 - 5. Furnished with selectable sensitivity.

6. Acoustic Glass Break Detectors: Designed to analyze ambient sound and activate upon detection of specific audio patterns representative of the sound of breaking glass.
7. Acoustic/Shock Dual Technology Glass Break Detectors: Designed to detect breaking glass using a combination of ambient sound and vibration analysis.

2.05 PANELS

- A. Manufacturer product to be Bosch.

2.06 ACCESSORIES

- A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.
- B. Provide wireless receivers and repeaters as indicated or as required for communication between wireless devices and alarm control unit; provide tamper protection.
- C. Provide cables as indicated or as required for connections between system components.
- D. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 1. Use listed plenum rated cables in spaces used for environmental air.
 2. Install wiring in conduit where required for rough-in, where required by authority having jurisdiction, and where exposed to damage.
 3. Conduit: Comply with Section 26 05 33.13.
 4. Conceal all cables unless specifically indicated to be exposed.
 5. Cables in the following areas may be exposed, unless otherwise indicated:
 - a. Equipment closets.
 - b. Within joists in areas with no ceiling.
 6. Route exposed cables parallel or perpendicular to building structural members and surfaces.

- D. Provide grounding and bonding in accordance with Section 26 05 26.
- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- F. Identify system wiring and components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Prepare and start system in accordance with manufacturer's instructions.
- D. Inspection and testing to include, at a minimum:
 - 1. Test each initiating device for proper response by alarm control unit.
 - a. Test glass break detectors using only manufacturer's recommended glass break simulation test units.
 - 2. Test for proper operation of alarm notification appliances.
 - 3. Test for proper operation of output relays.
 - 4. Test for proper operation of communication interfaces and central station reporting.
 - 5. Test for proper interface with other systems.
- E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 77 00 - Closeout Procedures, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of system to LACCD, and correct deficiencies or make adjustments as directed.
- D. Training: Train the University's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

END OF SECTION

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SECTION 28 20 00

VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Architectural Drawing Package, marked for Bid, and any current revisions noted by project management.
- C. Security systems drawings and other attached appendices and tables.

1.2 DEFINITIONS OF TERMS

- A. Owner: shall refer to LACCD, and all subsidiaries and affiliates
- B. Architect: shall refer to TBD.
- C. Consultant: shall refer to Vantage Technology Consulting Group. Refer to "PART 1, SUBMITTALS" for any specific identification.
- D. Project/Construction Manager (CM): TBD
- E. General Contractor (GC): shall refer to the lowest responsive GC awarded the construction contract.
- F. Bidder: shall refer to any party proposing to provide the services and material delineated in this Specification.
- G. Bid: shall refer to a Bidder's proposal to provide the services and material delineated in this Specification.
- H. Integrator: shall refer to the awarded contractor for this scope of services.
- I. CCTV Specification (Specification): shall refer to the complete set of designs, performance and delivery requirements delineated within this document and all referenced documents.
- J. CCTV System (Security System): shall refer to the complete complement of equipment, software, and other material that upon completion of assembly, installation and configuration provides the full functionality and technical performance delineated in this Specification.
- K. CCTV Equipment (Security Equipment): shall refer to all individual equipment items and equipment items supplied by Division 282300 Contractor installed as a part of the Video Surveillance System.
- L. Work: Design and provision the CCTV Systems and associated equipment, software, and services for the Project.
- M. Construction Documents: shall include all documentation associated with the design and general construction of the Project, including this Specification.
- N. Provide: Supply (furnish), deliver, install, test, configure, label, and commission.
- O. Manufacturer: shall refer to the original manufacturer of any equipment provided as part of the Work
- P. Commissioning Date: shall refer to the date at which a system is formally accepted by the Owner.

- Q. OFE: Owner Furnished Equipment.
- R. OFCI: Owner Furnished, Contractor Installed.
- S.
- T. CFCI: Contractor Furnished, Contractor Installed.

1.3 SCOPE/DESCRIPTION OF WORK

- A. The work covered in this Specification consists of furnishing all labor, material, and services to install a complete CCTV system as indicated on the project documentation, including this specification and related drawings.
- B. Contractor shall be responsible to program and to provide new IP cameras with associated licenses for NVR and network video recorder at campus MDF with existing LACCD standard Enterprise video management system (VMS). New NVR shall be extension of the existing LACCD standard Mileston VMS solution on campus.
- C. The work described in this Specification shall include, but not be limited to, the following Basic Services:
 - 1. Engineering and Design: The Integrator shall provide all system engineering and design necessary to develop the complete systems described herein. Engineering and Design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules, and lists.
 - 2. Procurement and Assembly: The Integrator shall procure and assemble all hardware and equipment and any additional materials as required to deliver completely functioning CCTV Systems.
 - 3. Software Programming: The Integrator shall perform all required software setup, configuration, and programming required to develop a complete operating system in accordance with this Specification, including all control logic and push-button component faceplate or interface programming.
 - 4. Installation: The Integrator shall install all equipment, cable, wiring, connectors, plates, and other material at the Project site per the Integrator's approved designs. The Integrator shall install any Owner Furnished Equipment identified in this document and calibrate it to work with the integrated systems.
 - 5. Testing and Adjustment: The Integrator shall perform all tests and adjustments, furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this Specification and the Integrator's approved engineered designs.
 - 6. Acceptance Testing: Prior to Owner acceptance and hand-over of the completed CCTV Systems, the Integrator shall demonstrate the operation of the complete systems, including all individual devices and specified control functions. Both subjective and objective tests may be required by the Owner to determine compliance with the information in this Specification and the Integrator's approved designs.
 - 7. Training: The Integrator shall provide technical training of Owner's staff, instructing them on CCTV Systems operation, maintenance, and troubleshooting.
 - 8. Warranty: The Integrator shall warranty the CCTV Systems in accordance with the terms of this Specification.
 - 9. Specific Responsibilities:
 - 10. The Preliminary Schedule below identifies critical Project milestones and delivery expectations currently anticipated. This information is provided for Bidder planning purposes only. The actual Schedule for delivery of the work shall be coordinated with the Owner's representative or Construction Manager.
 - 11. Refer to "BID SUBMITTALS", Section 1.06 and "SUBMITTALS", Section 1.08 .A for additional information and requirements.

1.4 REGULATORY REQUIREMENTS

- A. All onsite labor must be in compliance with job-site union requirements.
- B. The Integrator must obtain any permits and shall pay all fees required by public agencies having jurisdiction over the Work.
- C. All products and materials provided shall be listed by Underwriters Laboratory (UL) and shall bear the UL label intended for the purpose specified and indicated. If UL has no published standards for a particular item, then other national independent testing standards shall apply, and such items shall bear those labels.
- D. All equipment and installations under this Specification shall conform to the latest editions of the following:
 - 1. NFPA 70 National Electrical Code.
 - 2. NFPA 72 – National Fire Alarm and Signaling Code
 - 3. IEEE C2 National Electrical Safety Code
 - 4. ANSI/TIA-568, -569 and -607 Telecommunications Standards
 - 5. IEEE 142 2007 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- E. The Integrator and its employees shall perform all work in compliance with current Occupational Safety and Health Administration (OSHA) guidelines and regulations and other safety and health requirements as may be mandated by the Owner or other authorities.
- F. The Integrator shall have a thorough knowledge of governing codes and standards in effect and having jurisdiction over the Project. Lack of awareness of any of the relevant codes and standards will not be accepted as a reason for non-compliance.
- G. The Integrator shall be responsible for providing cable and materials that comply with applicable codes and requirements of regulating bodies. The cost for these materials shall be included in the Bid price, as the Owner shall not accept change orders for changes in materials.

1.5 COORDINATION OF RELATED WORK WITH OTHERS

- A. Related Work Specified Elsewhere: The Integrator shall coordinate with the Contractor and other construction trades to ensure proper integration and operation of the CCTV Systems with the complete Project designs, building systems and all other elements of the Project. The Integrator should request from the Owner, Contractor, or Architect complete project Construction Documents to help facilitate effective coordination of the Integrator's work with the work of others.
- B. Some components of the complete CCTV Systems will be provided by the Contractor, or Owner. It shall be the responsibility of the Integrator to coordinate with all parties whose work impacts the Integrator's work to ensure the complete coordination and successful implementation of the CCTV Systems. Related work by Contractor shall include, but may not be limited to, the following:
 - 1. Electrical Work (Division 26):
 - a. Electrical (AC) Power Service and Connections:
 - 1) Technical Power Service: All electrical panels, power receptacles, lighting fixtures, dimmers, lighting controls, and interconnecting wiring shall be supplied by Contractor.
 - b. Low Voltage Cable Containment

- 1) Low voltage cable containment, including raceways, conduits, and junction boxes, required to support CCTV System devices and interconnecting cabling shall be as specified in the Construction Documents and shall be provided by the Division 26 Contractor.
 - 2) Upon commencement of work on the Project, the Integrator shall review the Construction Documents to confirm that the infrastructure provided is sufficient to accommodate the CCTV Systems to be installed. Any conflicts or issues must immediately be brought to the attention of the Construction Manager, and the Consultant.
 - 3) The Integrator shall provide blank cover plates or panels for all wall and ceiling boxes that are dedicated to the CCTV Systems but do not have devices and/or connectors at the time of CCTV System commissioning. Colors and types shall be coordinated with the Architect.
2. Metals (Division 5)
 3. Rough Carpentry (061053)
 4. Joint Sealants (079200)
 5. Finishes (Division 9)
 6. Information Technology Systems : Unless otherwise specified, all data networking cabling shall be provided by Section 271300 and 271500 contractor(s) and the Owner. Unless otherwise specified, all active data networking electronics shall be provided by the Section 272000 contractor and the Owner. Patch cords to connect CCTV equipment to a data network port shall be provided by the Integrator. The Integrator shall be responsible for coordinating with the Owner or the Owner's designated representative regarding connections between the CCTV Systems and the Owner's data network, including all client/server computing and peripherals, Internet, digital video storage and other data/media distribution systems. Unless otherwise specified, equipment racks and cabinets, PDU's, and UPSs shall be provided by the Section 271100 contractor and/or the Owner. Coordinate with those entities to ensure space is available for any rackmounted equipment.
 7. Other Systems: The Integrator shall be responsible for identifying and integrating with any other technology systems and services required to deliver the completely operating CCTV Systems.
 8. Equipment Mounting and Support:
 - a. Structural support for CCTV system equipment shall be provided by Division 2823000 Contractor as noted and detailed in the Construction Documents. The Integrator shall coordinate with the Contractor and other trades as necessary to ensure compatibility of the structural supports provided by others with the CCTV Equipment provided by the Integrator.
 - b. The Integrator shall install all CCTV Equipment, including all camera and video monitor mounts, as indicated in this Specification and the Construction Documents. The Integrator shall verify location and structural suitability before attaching equipment and mounts. Any variations from the drawings and specifications or any question of structural integrity shall be brought to the attention of the Contractor, Architect, and Consultant before installing the equipment.

1.6 BID SUBMITTALS

- A. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors are not compensated for conditions that can be determined by examining documents or site and will not be relieved of any obligations with respect to bid.

- B. Questions: Submit all questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to all bidders as addenda and will become part of the Contract. The Architect and Owner may give, but will not be responsible for, oral clarifications. Questions received less than 10 days before bid date cannot be answered in writing.
- C. Equipment Availability: Verify with manufacturers' availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- D. Basis of Bids: To be eligible for Bid consideration, submit bids in accordance with the following:
1. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for all specified items. Itemization of miscellaneous equipment such as cable, switches, and receptacles are not required.
 2. Clearly indicate the total cost, including all expenses, for each individual system to allow the Owner to select any or all to be included in the contract. Itemization of miscellaneous equipment such as cable, switches, and receptacles are not required.
 - a. CCTV System
 3. Organize each list with the information presented, in the order that it appears in this specification, in 6 columns from left to right:
 - a. Paragraph number as it appears in this specification.
 - b. Paragraph title as it appears in this specification.
 - c. Manufacturer and model number.
 - d. Quantity.
 - e. Unit Cost.
 - f. Extension (unit cost times quantity).
 4. At the end of each list indicate the cost of all other items such as for miscellaneous equipment, engineering, installation labor, overhead, taxes, etc.
 5. On a separate list indicate costs of any specified add- or deduct-alternates with the information presented in the same manner as for the base-bid system.
 6. Include a listing of any voluntary alternates proposed by the bidder as substitutions or additions to the specified systems.
 7. Include any notes or comments, if necessary, to qualify the bid.
 8. Identify any sub-contractors and indicate the work they are to do.
 9. Provide documentation of ability in installing similar systems. Furnish the names, addresses and telephone numbers of the System Designer, Architect, Contractor and Owner on three projects similar in scope, which the Contractor has installed within the last 5 years.
 10. Identify the proposed project management, engineering, and installation staff. Include resumes for each individual indicating relevant experience and certifications.
 11. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required, and the date of last calibration traceable to NIST, as applicable.
 - a. GENERAL CONTRACTING
 - 1) Multimeter.
 - 2) Cable Tester (Kopul CBT-MF or similar).
 - b. VIDEO
 - 1) Multi-frequency computer test pattern generator with DVI output.
 - 2) Photometer with luminance and illuminance probes.

- 3) Fiber-optic testing and field servicing equipment.
 - 4) Category 6A F/UTP testing and field servicing equipment.
12. Include certification of ownership and full familiarity with the operation of the following minimum software and analysis tools:
- a. AutoCAD, version as required by the Owner (or .dwg compatible software, Stardraw not acceptable).
 - b. Revit, version as required by the Owner; or other BIM software, version as required by the Owner.

13. BIDS NOT FULLY ITEMIZED OR NOT SUBMITTED IN THIS FORMAT WILL BE REJECTED.

E. Delivery Schedule:

1. Unless otherwise directed in Division 0, within 14 days of receipt of bid package provide:
 - a. Basis of bid documents, including:
 - 1) Itemized equipment costs for specified equipment or APPROVED substitutions.
 - 2) Qualifications/References
 - 3) Certifications (including certificate of bonding, if required) 4) Proposed payment terms.

1.7 QUALITY ASSURANCE

- A. Project Management: Maintain the same person in charge of work throughout installation. Engineering and construction supervisors shall be ESA CSI or approved equal.
- B. Contract Documents: always Maintain a complete set of system drawings and specifications at the site during installation.
- C. Fabrication and Installation: Fabricate all equipment racks and subassemblies, as required. Make field connections of all video and control wiring including video, and control system circuits to equipment, equipment racks, and connection panels. Continuously supervise the installation and connections of cable and equipment.
- D. CCTV System Contractor Qualifications: To be considered qualified for this work, bidders must meet the following standards:
 1. The Contracting firm is experienced in the provision of CCTV systems similar in complexity to those required for this project.
 2. The Contractor's primary business is the provision, fabrication, and installation of professional CCTV and related systems.
 3. The Contractor has been regularly engaged in the installation and service of professional CCTV systems for a period of at least five years.
 4. The Contractor is an authorized dealer for the major products furnished.
 5. The proposed Project Engineer holds ESA CSSI certification or approved equal. The proposed installer holds ESA CVT certification or approved equal.
 6. The Contractor is certified by the manufacturer of the systems to install and configure all components of the system. The Contractor must assign a certified technician to conduct the work. Contractor must submit proof of certifications with the bid response.
 7. Additional certifications specific to project – manufacturer's certifications, etc.
 8. The Contractor is experienced in cloud-based control and management systems.
 - a. At the request of the Owner, Owner's representative, or Architect, demonstrate the following capabilities:

- b. Adequate plant and equipment to complete the work in accordance with the project schedule.
 - c. Sufficient staff with appropriate technical experience to oversee and execute the work.
- E. Subcontractors: The Contractor may arrange for sub-contract field and special shop work to be done by others.
- F. Prime Contractors: Any other installer who intends to bid on this work as the Prime Contractor and does not meet the "Contractor Qualifications" described above shall employ the services of a single "CCTV Systems Contractor" who does meet these requirements. The CCTV System Contractor shall Furnish and Install the equipment. The Prime Contractor shall clearly identify the CCTV Systems Contractor and submit complete qualification information for the CCTV Systems Contractor in the Bid. Failure to do so will be cause for rejection of the Bid.

1.8 QUALITY ASSURANCE

A. General:

1. The Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Architect, that the proposed product is similar and equal to the named product. B. Documentation:

1. File a formal request for each substitution, documenting the conditions outlined below, including:
 - a. Complete data on the proposed substitution, substantiating compliance with the CCTV Systems Contract Documents, including:
 - 1) Specification Section and description of the equipment or service originally specified by the Consultant
 - 2) Product manufacturer, model, and description of the proposed substitution
 - 3) Performance specification and test data verifying the proposed substitution's compliance with CCTV System and installation requirements.
 - 4) References and samples, where applicable
 - 5) An itemized comparison of the proposed substitution with the item originally selected in the CCTV Specification
 - 6) The impact of the proposed substitution on the Contract time schedule, system design, artistic effect (for changes in finish or dimension), and related contracts and trades

2. Submit item comparisons, coordination schedules, and design impact via addenda appended to manufacturer documentation. C. Basis:

1. Requests for acceptance of proposed equivalents made following the award of bid are considered only in the following cases:
 - a. The named products cannot be obtained by the Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Contractor makes a written request for consideration of the proposed equivalent.
 - b. The proposed equivalent is approved as equal or superior to the named product and its use is to the advantage of the Owner. D. Consideration:
 1. A request for substitution is a representation by the Contractor that:
 - a. The Contractor has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - b. The same warranty is provided for the substitution as the original equipment specified.

- c. The cost data presented is complete and includes all related costs under this Contract but excludes costs under separate contracts and excludes Architect's redesign costs, and that the Contractor waives all claims for additional costs related to the substitution which subsequently becomes apparent.
 - d. Any cost impact on work by other trades is indicated.
 - e. Installation of the accepted substitute will be coordinated by the Contractor, making such changes as may be required for the Work to be complete in all respects.
2. An accepted substitution shall be documented by Change Order, effectively modifying the CCTV Systems Specification. The Contract Price will be changed only if the substitution results in cost savings to the Owner.

1.9 CONSTRUCTION SUBMITTALS

- A. Coordinate all submittals with requirements set forth in Section 013300.
- B. Bill of Materials & Manufacturer Product Data Sheets:
 1. Organize the Bill of Materials with the information presented in the order and format that it appears in this specification.
 2. After the Bill of Materials, include Catalog Data Sheets ("cut" sheets) for all specified products arranged in the order listed in the Bill of Materials.
 3. Clearly indicate all finishes, colors and, options for equipment.
 4. As an alternative, provide product data sheets in electronic .pdf format, or other approved file format. Datasheets shall be organized in a logical manner, such as per system, to allow efficient review against the design documents. C. Shop Drawings:
 1. Size: minimum 24" x 36" unless otherwise specified.
 2. Media: provide in electronic .pdf file format unless otherwise specified or directed by the Construction Manager.
 3. Prepare a drawing package on the approved Computer Aided Drafting (CAD) or Building Information Modeling (BIM) system, including:
 - a. Integrator name, address, and phone number.
 - b. Block diagrams indicating proposed connections of all equipment and indicating equipment brand and model numbers.
 - c. Equipment/ control room layout and equipment rack and cabinet details
 - d. Provide detailed drawings of custom-fabricated or stock mounts and hardware.
 - e. Video display arrangements.
 - f. Other drawings and sketches as required by the Architect or Consultant during project installation.
 4. Design drawing files provided by the Architect and/or Consultant as a courtesy in aiding the Integrator in preparing Shop Drawings must be modified to include the information specified above. Submitting design drawings without these modifications is not acceptable.
- D. Data Network Connectivity
 1. Any system, or components of a system, provided in this specification section which are to be connected to the Owner's data network either via wired or wireless connections will conform to the requirements described in PART 3 - EXECUTION. Vendors shall review the requirements of this section and provide a statement of compliance for each item that either:
 - a. Confirms that the proposed System (or any applicable components of the System) is compliant with the requirements listed in the item, or

- b. Explains why the proposed System (or any applicable components of the System) is not compliant, including any potential mitigation measures that may resolve the non-compliance issue.

E. Project Plan

1. Provide a complete and detailed Schedule for the Integrator's work describing the major tasks, sequence of work, submittals, and other critical milestones. At a minimum, the tasks noted in the Schedule shall include all required submittals, rack assembly, and shop testing, on site cable installation, periodic shop, and site visits, on site equipment installation, testing and commissioning, Substantial Completion and Project Completion. Indicate the sequence of installation and completion by area and/or system. The Schedule shall also include anticipated dates of acquisition of major equipment and their installation milestones.
2. Provide a complete listing of the Integrator's project team, including the names and all contact information (email address, cell phone, etc.) for all personnel assigned to the Project. At a minimum, this Project Team Directory shall include the Integrator's executive in charge of the Project as well as the Project Manager, Lead Engineer, and Lead Installer. Include names and contact information for Contractor.

F. Weekly Status Reports

1. If directed by the Construction Manager, the Integrator shall provide weekly progress updates to the Architect and Consultant. Weekly Status Reports shall be submitted as directed by the Construction Manager via faxed hard copy or electronic means (i.e. email). Issuance of Weekly Status Reports shall commence from the date of the first submittal delivery and shall continue until contract closeout.
2. The Weekly Status Report shall not be used as an official means of communicating Project issues. It does not replace any part of a required submittal, request for information, proposed change order, report of field conditions, schedule issues, etc. No official response will be given to the Weekly Status Report.
3. A representative of the Integrator shall attend the weekly construction meeting at the job site. This representative shall be fully knowledgeable in all aspects of the Project and the Integrator's work and shall have the authority to make binding commitments on behalf of the Integrator.

G. Substantial Completion Submittals

Substantial Completion of the CCTV System installation shall be the point at which all CCTV Equipment has been installed, programmed, configured, and initially tested to confirm proper operation. The point of Substantial Completion shall be as mutually agreed between the Integrator and the Consultant following discussion and observation. At the point of agreed Substantial Completion, the Integrator shall submit the following:

1. Test Reports:
 - a. Upon completion of SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS specified in PART 3 - EXECUTION, submit for approval in writing test results including numerical values for all measurements.
 - b. Submit written certification that the installation conforms to specifications, is complete and operable, and is ready for FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION.
 - c. The Owner or Owner's representative reserves the right to withhold the final site visit "check-out" and any final certification of project completion until receipt of test report documents, as outlined in this section (SECTION 1 – "Test Reports").
2. Preliminary Project Record Documents Submittal
 - a. Upon Substantial Completion, the Integrator shall submit Preliminary Project Record Documents to the Consultant. Preliminary Project Record documents shall be submitted prior to the Preliminary Checkout.
 - b. Preliminary Project Record Documents shall include:
 - 1) Corrected/updated shop drawings
 - 2) Updated Equipment List
 - 3) Half-size drawings modified to reflect the actual installation conditions
 - 4) USB Flash Drive or other approved media with manufacturers' operation manuals arranged alphabetically and current drawings in .DWG format
 - c. Consultant's Preliminary Checkout will be scheduled after the Preliminary Project Record Documents and Test Reports have been approved.

H. Manufacturer's Owner's Manuals:

1. Archive all Manufacturers' Owner's Manuals for specified equipment in the following manner:
 - a. One original (not photocopy) manufacturer's owner's manual per equipment item.
 - b. Submit in a 3-ring binder including a cover page and spine insert identifying the project, site location, and submittal.
 - c. Arrange manuals in alphabetical order, by manufacturer.
 - d. Provide a table of contents and separate each section within the binder with tab dividers.
 - e. If approved by Owner, provide all Manufacturer's Owner's Manuals in electronic .pdf format on USB Flash Drive or other approved media. Owner's Manuals shall be organized in a logical manner such as per system and/or alphabetical order, by manufacturer. I. User Operational Manual:

1. Intent: Prepare in the form of a system operations manual for use by Owner's personnel. System documentation shall be adequate such that a person trained on the System, but with no familiarity with this specific implementation, shall be able to understand the configuration and implementation of all major and minor systems as well as how these systems are integrated to form the overall System.
2. Cover: Identify each volume with typed or printed titles "SYSTEM OPERATING INSTRUCTIONS".
3. Format: Submit the User Operational Manual in the following format:
 - a. Size: 8-1/2" x 11", 20 lb. minimum weight white paper for typed pages, either manufacturer's printed data, or neatly typewritten.
 - b. Drawings: Provide reinforced punched binder tab, bind in with text. Fold larger drawings to size of text pages.
 - c. If approved by Owner, provide Operational Manual in electronic .pdf format on USB Flash Drive or other approved media.
4. Content of Manuals: Prepare the User Operational Manual with the following content:
 - a. Neatly typewritten table of contents for each volume arranged in systematic order. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - b. Contractor name of responsible principal, address, and telephone number
 - c. Certificate of Warranty
 - d. Service Contract: Include a preliminary schedule for the specified semi-annual site visits.
 - e. Complete as-built diagrams for systems.
 - f. Receptacle Location Plan
 - g. Shop drawings of all custom-fabricated items
 - h. Control Setting Schedule.
 - i. Documentation of all touch-panel screens both in the form of data files on USB Flash Drive, or other approved media, and graphical printouts.
 - j. CCTV control system configuration files on USB Flash Drive, or other approved media, for the management and control system, or other software required for reconfiguring the CCTV management and control system. J. System Diagrams:
 1. Provide sufficiently clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation, based on diagrammatic representations of the installed system.
 2. Provide drawings showing all terminal blocks, connectors, relays, switches, equipment, components, and wires.
 3. Provide layout drawings of panels and other custom assemblies containing switches, relays, terminal blocks, receptacles, etc., using reference numbers to identify physical locations of devices or label devices with reference numbers in a location visible while viewing cable terminations.
 4. On wiring diagrams, label all conductors within cables for insulation color or other identifier.
 5. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number.
 6. If device does not provide terminal designations, provide key diagram for reference.
 7. Label all devices with manufacturer, model number, and reference number (e.g. "SW 15", "TB 6"); reference numbers shall be consistent across all drawings with no repetitions.

8. Provide labels for cables continued onto another drawing, indicating termination device, terminal numbers, and drawing sheet on which the termination is shown.
9. Illustrate all receptacles, patch panel jacks, and switches.
10. Receptacle Location Plan: Plan drawing of area showing locations and designations of all receptacles.

K. Forward all submittals to:

1. The Project Manager, or as directed.

L. Sustainable Building Submittals

1. Sustainable Building Submittals are required to verify compliance with the "Sustainable Building Performance Criteria" defined in this section.
2. Refer to Division 1 Section "Sustainable Design and Construction," for detailed descriptions of the submittal documents listed below.
3. Green Building Materials Certification Form (GMF): Submit a completed GMF for the materials included in this section (blank copy is appended to Division 1 Section "Sustainable Design and Construction"). The following information shall be provided:
 - a. Itemized material costs for the Green Building Focus Material (GBFMs) identified under the "Sustainable Building Performance Criteria" heading of this section.

1.10 JOB CONDITIONS

A. Sequencing and Scheduling:

1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
3. Staff the job to keep pace with the other Trades; otherwise, the project manager will require an increase in force or overtime work without additional expenses to the Owner.
4. Abide by the decision of the project manager in case of conflict or interference by other trades.
5. Remove all refuse from the job site to the satisfaction of the Owner's representative.

B. Do not install equipment in dusty conditions or allow dust to accumulate in or on installed CCTV Equipment.

C. Protect all work and equipment from damage by others.

D. Protect all existing work-in-place by others from damage by the Integrator, any employees or vendors. The Integrator will be solely responsible for any/all damage to work-in-place by others.

E. Keep areas around and inside of each piece of equipment and each rack free from dust, dirt, and debris throughout the project. Equipment that is not properly maintained during installation shall be replaced at no cost to the Owner before final payment is made to the Integrator. F.

Storage and Staging:

1. The Contractor is ultimately responsible for acquiring secure storage at the job site. Coordinate with project management and/or Owner to determine the location and size of the storage area.

2. All Integrator equipment and materials and all owner furnished equipment turned over to the Integrator stored at the Integrator's facility(s) or stored and/or installed at the Project site will remain the property of the Integrator unless ownership is legally transferred and accepted in writing by the Owner. The Integrator shall be solely responsible for the protection of all equipment from damage, theft, or vandalism regardless of cause, until the work described herein is accepted by the Owner at the time of Final Checkout. G. Refuse and Repair:
 1. Upon completion of work remove all associated debris, waste, refuse, and rubbish from premises. Leave all areas and equipment within the scope of this contract clean, free of blemishes, and operational.
 2. Repair any damage to the premises, at no cost to the Owner, caused by the Contractor. H. Adhere to the safety standards established by the Contractor while performing work on site.
 - I. All employees of the Integrator shall wear identification clearly indicating the Integrator's company name while on site.
 - J. All employees of the Integrator shall comply with rules and policies established by the Owner and/or the Contractor.
 - K. All vehicles of the Integrator or employees shall be parked in areas designated by the Owner and/or the Contractor.
 - L. Environmental Impact Considerations
 1. The Integrator is expected to comply with project specific practices and environmental considerations to comply with any LEED objectives and local environmental regulations.
 2. The Integrator is encouraged to utilize environmentally sustainable materials and work practices in the delivery of the Work. This may consist of (but not be limited to): a. Energy Efficiency/Conservation
 - b. Waste Reduction/Recycling
 - c. Water Conservation
 - d. Pollution Prevention
 - e. Employee Education Programs
 - f. Transportation Planning
 - g. Utilization of Renewable Materials
 - h. Minimize Emission of Greenhouse Gases
 3. Upon request, the Integrator shall supply documentation on in-house policies for recycling and environmental offset goals. M. Promotion/Publication:
 1. The contractor does not have the rights to use any information or images, relative to this contractor installation, for publication or in promotional materials without the express written permission of the Owner, Architect, and Vantage Technology Consulting Group. Upon approval, the contractor must disclose full credit to the Architect and Consultant for facilities and system design.
- N. Insurances on the work of this specialty trade shall be provided as specified in relevant project documentation.
- O. Inspection

1. Notify the Architect of any defects in work by other trades affecting installation.
- P. Packaging: Material and equipment manufacturers shall demonstrate efforts to reduce packaging waste and/or to use environmentally-preferable packaging materials. Examples include, but are not limited to, the following:
1. Reusable and/or returnable pallets or crates
 2. FSC-certified wood or salvaged wood pallets or crates
 3. High recycled-content cardboard, paper, steel, or plastic packaging
 4. Bio-based foam packing materials

1.11 QUALITY ASSURANCE

A. Project Description

1. The project concerns the installation of new video surveillance systems in renovated spaces at the name of project in location, as described below and shown on the drawings.

B. Functional Requirements of Systems

1. CCTV System

- a. Interior and exterior IP cameras to capture video of sufficient quality for recognition of individuals.
- b. All cameras and video management software must be ONVIF compliant to ensure interoperability with future adds or changes.
- c. Recording to be motion-based, 24/7, with 30-second pre-record. Provide storage for 30 days at a minimum of 30 fps, 1080p resolution from cameras.
- d. Video to be reviewed at existing security viewing stations in the Hospital. Cameras will not be monitored 24/7. Configure system for remote access so that video can be reviewed by the Owner's corporate headquarters, or other locations as directed.

PART 2 - PRODUCTS

2.1 ENGINEERING AND DESIGN

- A. Engineering and other pre-site services included in this Specification are considered furnished goods delivered to the site in a similar manner to physical materials. PART 2 of the CCTV specifications is for review by the Contractor. The contractor is responsible for reviewing the specification and drawings and providing an ENGINEERED fixed-price quotation covering the cost of all equipment and labor to install, program, warranty, and service the systems described.
- B. The contractor is responsible for attending all pre-bid meetings and reviewing and understanding the systems design, functionality, and intent.
- C. The owner assumes that all contractors providing bid responses have included all of the necessary equipment, parts, cabling, labor, engineering, programming, project management, testing and training costs, and will not approve any additional fees or costs, unless shown and approved to be beyond the scope of the specification and drawings.

- D. The equipment identified below provides examples of the level of quality and functionality required. These are predominantly major or unusual items and do not represent a complete list of equipment. The contractor is responsible for providing all equipment necessary for fully functioning turnkey systems.
- E. Where the equipment described includes “or approved equal”, the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions to allow the owner or owner’s representative to make a determination prior to bid submittal.
- F. Where the equipment described includes “or equal”, the contractor shall provide all documentation as indicated in paragraph 1.08 Substitutions as part of the product data submittal package delivered after award of contract.
- G. Where the equipment described does not include “or approved equal” or “or equal”, the contractor shall provide only the product specified. No substitutions will be accepted.

2.2 CAMERAS

- A. Indoor/Outdoor Camera (Fixed view): The minimum resolution of camera shall be (2592x1944) 5 MP and ONVIF compatible: Axis P3267-LV (indoor) P3267-LVE (outdoor). Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- B. Indoor/Outdoor 180-degree multi-lens Camera (Panoramic view): The minimum resolution of camera shall be 14 MP and ONVIF compatible: Axis Q3819-PVE (Ceiling/wall mounted); Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- C. Exterior/Interior 360-Degree Camera : The minimum resolution of camera shall be 4X2 MP and ONVIF compatible: Axis P3727-PLE (Ceiling/wall mounted); Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- D. Pan, Tilt, Zoom (PTZ) camera –The minimum resolution of camera shall be 5 MP and ONVIF compatible: AXIS Q series (Ceiling/wall mounted/pendant mounted); Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- E. License Plate Recognition Camera – The minimum resolution of camera shall be 2 MP and ONVIF compatible: Axis Q1700-LE (exterior wall mounted); Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- F. Elevator camera –Indoor fixed lens camera (Panoramic view): The minimum resolution of camera shall be 2 MP and ONVIF compatible: Axis P91 Series (wall mounted); Cameras shall be provided with housing and mounting accessories as appropriate for installation location and environment.
- G. Provide CAT 6A F/UTP cabling (Windy City or equal) from IP cameras to IDF room. Terminate CAT6A F/UTP cables at rack mounted dedicated RJ-45 patch panel. Coordinate location of patch panels with structured cabling contractor and LACCD IT.

2.3 NETWORK VIDEO RECORDER

- A. Provide network video recorder server with LACCD standard video management software.

- B. The NVR server shall have recording resolutions of CIF, 2CIF, D1 and 1080p and shall be user selectable for each individual camera attached to the server. H.265 video compression format shall be used for all video recording. Video recording shall be available at up to 30 frames per second per input channel.
- C. The NVR shall have Video Surveillance Management System (VSMS) software for viewing live and recorded video from IP cameras and video encoders connected to a local and wide area network. The VSMS software shall have a Client-Server based architecture that can be configured as a standalone VSMS system with the Client software running on the server hardware and/or the Client running on any network connected TCP/IP PC workstation. Multiple client workstations shall be capable of simultaneously viewing live and/or recorded video from a single or multiple server. Multiple servers shall also be able to simultaneously provide live and/or recorded video to a single or multiple workstation(s). Included in the cost of the software are an unlimited number of client software applications.
- D. The VSMS software running on the NVR shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing best of breed solutions from low-cost entrylevel features to high resolution megapixel features.
- E. Provide a minimum of 20 minutes UPS battery backup for Network Video Recording server.
- F. Programming Parameters
 1. System Name: Shall be the abbreviated building name (followed by a number, if multiple NVRs are in the building)
 2. Network Settings: NVR shall be connected to the LACCD LAN network. IP address will need to be obtained through LACCD IT.
 3. Camera setup and recording camera resolutions shall vary depending on the cameras selected and added to the NVR server. Cameras shall be set to record on motion-based, 24/7, with 30-second pre-record. Provide storage for 30 days at 15 fps and full resolution from cameras. Alarm parameters shall be set to mask motions other than intended targets. LACCD shall provide camera naming conventions. All cameras must be named prior to placing system into operation.
 4. Programming of the system shall include the following tasks:
 5. Programming system configuration parameters (hardware and software, camera location/number, communication parameters)
 6. Other programming tasks required by the Owner. These additional programming requirements shall be coordinated between the Owner and the Contractor.

2.4 VIDEO MANAGEMENT SYSTEM

- A. Video Management System: Expand existing Milestone Video Management System on campus. Integrate fully with Lenel OnGuard.

PART 3 - EXECUTION

3.1 GENERAL

- A. All types of equipment installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- B. All delivered equipment, except portable equipment, firmly fastened or held in place. "Delivered equipment" includes cameras, video monitors, etc. Apply a minimum safety factor of four (4) times the load for all equipment fastenings and supports.

- C. Take necessary precautions to prevent and guard against electro-magnetic and electro-static hum and to install the equipment to provide safety for the operator.
- D. Protect all equipment, including patch panels, connectors, receptacles, racks, and consoles, from construction dust and debris until final acceptance of the system.

3.2 INTEGRATION/INSTALLATION

A. Conformance to Existing Facility Standards

1. Wherever possible provide equipment, finishes, and interfaces similar in nature to systems already in use by the Owner. Provide uniform functionality and operation to enhance ease of use and minimize instruction. Provide uniform finish and equipment to enhance the aesthetic unity of systems facility wide, and to improve end-user familiarity with equipment.
2. Equipment Integration:
 - a. New Equipment: Unless otherwise specified, supply only new equipment, parts, and materials, and protect all equipment from construction dust and debris until final acceptance.
 - b. Equipment Handling and Wear: Operate specified equipment only as required for testing, as part of the installation procedure.
 - c. Single Source: The provision of all manufactured components, installation, wiring, and testing is the responsibility of a single contractor.
 - d. All equipment and installations under this Specification shall conform to the latest edition of the following:
 - 1) ANSI/NFPA 70 National Electrical Code.
 - 2) ANSI/IEEE C2 National Electrical Safety Code
 - 3) ANSI/TIA Standards 568, 569 and 607
 - 4) IEEE/ANSI 142 2007 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
3. Equipment Quantities:
 - a. Determine and provide the quantities of installed equipment based on the Bid Documents including the plans, functional diagrams, riser diagrams, and specification.
 - b. Quantities of portable equipment are indicated in schedules contained in the drawings or specifications.
4. Engineering and Documentation:
 - a. The system drawings indicate the general layout of the various items of equipment and their functional relationships. Layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item or parameter required for a complete installation.
 - b. The Contractor shall provide any incidental equipment needed to result in a complete and operable system even if not specified or shown on drawings without claim for additional payment.

B. Labels

1. Dry transfer, "Dymo", or other types of adhesive labels not acceptable

2. Except where otherwise specified label as shown on drawings, and as specified, each item of rack-mounted equipment and all switches, controls, and receptacles
 3. Switch and Control Panels: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness.
 4. Rack-Mounted Equipment: Labels constructed of engraved and filled plastic laminate engraving stock. Designate function and input and output line(s) or loudspeaker(s) served by labeled equipment. Key all designations to system functional and patch panel diagrams. Where possible, mount labels on blank panel directly above corresponding component. For modular equipment, provide label on inside of mainframe door identifying type of module for each slot (unless there is only one type) and gain setting as established at final checkout.
 5. Identification Panel: See drawings for layout and nomenclature. Contractor is responsible for completing all bracketed items with the appropriate project-specific information.
 6. Branding and Recognition: Identification of the contractor, or use of contractor logos or similar "trademarks" or "signatures" (including but not limited to touch panel graphics and color schemes, silk-screened or engraved corporate logos, copyrighted fonts, and/or custom emblazoned panels) is strictly forbidden except where explicitly indicated within the bid documents. Any unauthorized use of these marks will be rejected.
 7. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on drawings.
 8. Patch Panels: Labels for jacks constructed of engraved and filled plastic laminate engraving stock or printable composition material with clear plastic cover. Labels for jack rows constructed of engraved and filled plastic laminate engraving stock. Paper strips may be used as temporary labels only.
 - a. Label jacks with functional description of jack ("Camera 1", "Console Input 4", etc.).
 - b. Color-code jack labels with different colors for video level jacks, input and output jacks for recording/playback equipment, and other line-level jacks.
 9. Identify all wires and cables at every termination and connection point in accordance with the Owner's standards using the specified cable markers, unless otherwise instructed by the Owner. Use a numbering scheme that identifies all cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and C suffixes to distinguish multiple cables terminating at the same jack. Submit proposed numbering scheme for approval prior to installation.
 10. Identify switches, relays, terminal blocks, etc., with reference numbers keyed to the asbuilt wiring diagrams.
 11. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.
 12. All labels and legends shall be as approved on shop drawings.
- C. Racks, Cables, Connectors, and Miscellaneous Equipment
1. Wiring and Interconnections:
 - a. General:
 - 1) Exercise care in wiring to avoid damage to cables and equipment.
 - 2) Make all joints and connections with rosin-core solder or approved mechanical connectors.
 - 3) All wiring executed in strict adherence to standard security practices. This includes:

- a) Dress cables in conveniently sized bundles, combed into parallel runs, either laced or banded with sufficient plastic ties.
 - b) For equipment mounted on glides, or otherwise requiring servicing from the front of the rack incorporate a cable "service loop" of sufficient length to permit the equipment to be pulled forward from the rack for servicing.
 - c) Support cables and bundles with sufficient plastic ties and support bars to ensure that no strain is placed on any connections or connectors.
 - d) Organize cables and cable bundles behind patch bays to permit easy access to the patch panels to add or remove cables.
 - e) Place cable markers 3"-5" back from video connectors to permit easy viewing. Do not bind markers into cable bundles.
- b. Grounding:
- 1) If not shown on drawings, ground case of power strip lines in equipment racks to the racks and directly to isolated ground buss in the power panel or to power system ground at the building AC service entry only.
 - 2) Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from CCTV system, including equipment racks.
 - 3) Insulate all conductors in conduit, including shields, from the conduit, back boxes, and from each other for the entire conduit length.
- c. Equipment Racks:
- 1) Install equipment in racks to permit access to all equipment for service. Relays, terminal blocks, etc., mounted in rear of racks behind other equipment shall not prevent access to equipment connections or shall be mounted on hinged panels to permit access.
 - 2) Where racks or cabinets are provided under this Section, wire all racks completely in the shop. No internal rack wiring to be done on the job site.
 - 3) Install equipment in racks with ventilating panels as required to provide adequate ventilation and according to equipment manufacturer's recommendations.
 - 4) Where racks or cabinets are provided under this Section, provide unused panel space with blank or ventilating panels as shown on drawings.
 - 5) Locate free-standing racks as indicated in the Telecom drawings and to provide access to rear.
- d. Conduit:
- 1) Run all lines in metallic conduit or wireways unless otherwise indicated.
 - 2) Do not locate AC power lines in conduit containing video lines. 3) Do not splice lines in conduit.
- e. Receptacles:
- 1) Provide finish sample for approval by Architect.

- 2) Wall-mounted receptacles in metal boxes at building standard receptacle height unless otherwise indicated.

f. Video Receptacles:

- 1) Install feed-through receptacles to mounting plates with insulating washer and sleeve to electrically isolate the receptacle from the electrical box and conduit.
- 2) Punch receptacles with "D" hole to prevent receptacle rotation within hole.

D. Wiring

1. Install systems wiring in accordance with the latest edition of local codes.
2. Any miscellaneous Ethernet cabling required, but not installed under Division 27, must be installed in accordance with Division 27.
3. Low voltage cabling above access ceilings shall be grouped and supported every 3' (and within 6" of terminations) with clips intended for this use. Low voltage cabling in new wall construction shall be run in EMT sized to no more than 40% fill capacity.
4. Label and color code wiring systems with labeling and coding shown on shop drawings.
 - a. Use white conductors only for neutral conductors and green only for grounding conductors.
 - b. Group conductors within junction boxes, pull boxes and equipment enclosures and lace with nylon tie straps with identification tags in individual sets, serving individual locks or groups. Conductor group shall be identified on the tag with respect to room or area served.

E. Cameras

1. The Contractor shall not install any camera in the field until a walkthrough has been scheduled for visual placement of the cameras with final approval from the design team, the locations shown on the drawings are for reference purposes only, the Architect and Owner shall sign off on all final locations prior to the installation of the final devices with possible relocations based upon site conditions, these services shall be included in the contractors base bid.
2. Set for Auto-Iris.
3. Set ABL (auto black level) off.
4. Set color temperature filter to setting 1.
5. Set Gain to 0 dB.
6. Determine a white-balancing procedure for normal use. Determine if an appropriate white area is available in each room or can be made available prior to each room use. If providing white surface for each day's use is difficult, evaluate the effect of using the preset 3200°K color temperature setting. Consult with Owner to confirm procedure suitability. Note that following camera shutdown, white balance, iris, and pedestal adjustments are stored in memory for a maximum of 12 hours. In the test results submission, report on findings.
7. Set lens Macro to "OFF".
8. Set horizontal and subcarrier phase for all cameras. Determine that all video signal parameters can be adjusted to within normal limits, with settings as described above.
9. Coordinate pan/tilt/zoom preset requirements with Owner, and program as required.
10. Cameras with Built-In Microphones: Disable microphones, unless otherwise instructed by the Owner.

11. IP Cameras: Coordinate network requirements, switch PoE requirements, IP addresses, VLANs, QoS, etc., with Owner's IT staff.
12. Configure camera frame rate, bit rate, resolution, and any other available parameters in accordance with the construction documents, unless otherwise instructed by the Owner or Consultant.

F. Network Video Recorders

1. Rack-mount each recorder in existing data center. Coordinate location with LACCD IT.
2. Coordinate network requirements, IP addresses, VLANs, QoS, etc. with Owner's IT staff.
3. Provide recorder with storage, as indicated in the Telecom Drawings, to achieve the desired capacity with the recording policies, resolution, bit rate, etc.

G. Video Management System (VMS)

1. Install the VMS software on NVR server.
2. Add Users, configure the system, add devices and groups, configure event management, and create and add E-maps, as directed by the Owner.
3. Integrate the VMS with the access control system using the VMS's API, if available.
4. Provide copies of all configuration and support files to allow the Owner to re-configure the system.

3.3 SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS

A. Test all equipment to verify conformance with manufacturer's performance specifications and with this specification.

B. At a minimum, the following items shall be verified:

C. Video System Performance Verification Item Numbers and Descriptions

1. VP-110 – Test Video Routes
 - a. Verify that all video routes are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and routing required by the project documentation.
2. VP-111 – Video Camera Image and Operation
 - a. Verify that cameras, lenses, and pan/tilt systems operate as defined in the project documentation. Inspect the camera image through the full lens operation.

D. Cable Management, Termination, and Labeling Verification Item Numbers and Descriptions

1. CABL-100 – Cable Bend Radius
 - a. Verify that cables are not bent beyond their minimum bend radius as specified in cable data sheet to maintain signal integrity as defined in the project documentation.
2. CABL-101 –Connector Plate Input and Output Labeling
 - a. Verify that all CCTV connector plate inputs and outputs are labeled as defined in the project documentation.
3. CABL-102 –Connector Seating
 - a. Verify that all CCTV connectors are correctly keyed, seated, and latched to respective connection points as defined in the project documentation. Conditions

where physical parameters exceed the connector's ability to maintain full seating should be resolved as defined in the project documentation.

4. CABL-103 –Connector Verification
 - a. Verify that all CCTV cable terminations are made securely and meet the recommendations of the connector and cable manufacturer(s), published standards, and requirements defined in the project documentation.
5. CABL-104 –Equipment Power Cable Management
 - a. Verify that all CCTV equipment power cables are managed as defined in the project documentation. Verify that cables are managed in a uniform and acceptable manner so as not to compromise safety/OEM warranty, CCTV signal quality, and/or future field service.
6. CABL-105 – CCTV System Cable Labeling
 - a. Verify that all CCTV system cables are identified by a unique ID as defined in the project documentation. Verify that this unique ID is displayed permanently at both ends of the cable, is legible, and is positioned where it can be seen without undue disturbance.
7. CABL-106 – Cable Separation
 - a. Verify that both site and rack cables have appropriate separation according to signal type and level as defined in the project documentation.
8. CABL-107 – Cable Supports
 - a. Verify that all cables are supported throughout their lengths as defined in the project documentation.
9. CABL-108 – Cable Ties
 - a. Verify that, where appropriate, cable ties are used to secure the cables, are correctly tensioned, and that the correct type of cable tie(s) is used as defined in the project documentation.
10. CABL-109 – Cables Bundled by Type
 - a. Verify that cables are only bundled together when their construction, signal type, and signal level are compatible and will not cause measurable crosstalk or interference between cables.
11. CABL-110 – Cables Dressed
 - a. Verify that cables are dressed to ensure that all rack and site cables are installed to provide serviceability, safety, and aesthetics as defined in the project documentation.
12. CABL-111 – Patch Panel Configuration
 - a. Verify that all patch panels have been correctly wired and configured as defined in the project documentation.
13. CABL-112 – Patch Panel Labeling

- a. Verify that all patch panels have been labeled as defined in the project documentation. Verify that all labeling is machine-printed, consistent, durable, accurate, and legible.
 - 14. CABL-113 – Termination Stress
 - a. Verify that all cable terminations have been completed and adequately supported to minimize stress on the termination point and/or connector.
 - 15. CABL-114 –Connector Plate Consistent Labeling
 - a. Verify that CCTV connector plates have consistent labeling throughout the project as defined in the project documentation.
 - 16. CABL-115 –CCTV System Cabling Verification
 - a. Verify that all cabling is the correct type and routed correctly from point to point as defined in the project documentation.
 - 17. CABL-116 – Cable Length Required for Serviceability
 - a. Verify that sufficient cabling is available so the device can be placed in a serviceable location as defined in the project documentation.
- E. Control Performance Reference Verification Item Numbers and Descriptions
- 1. CON-100 – Control System Communications
 - a. Verify that all control communications are tested from endpoint to endpoint via the appropriate midpoint(s) for operation and functionality as defined in the project documentation.
 - 2. CON-101 – Interfacing and Control of External Devices and Systems
 - a. Verify that CCTV control system interfaces to and from control systems provided by others conform to requirements as defined in the project documentation.
 - 3. CON-102 – Mobile Device Integration
 - a. Verify that mobile devices that are to be supported are integrated and operating as defined in the project documentation.
 - 4. CON-103 – System Response to Event Condition(s)
 - a. Verify that any required response of the installed CCTV system in the event of a configured event operates as defined in the project documentation.
 - 5. CON-104 – Control System Automated Functions
 - a. Verify that all time-dependent or automated functions executed by the control system conform to requirements as defined in project documentation.
 - 6. CON-105 – Control System User Interface Performance
 - a. Verify that the control system is implemented in a manner consistent with the requirements as defined in the project documentation.
- F. System and Record Documentation Reference Verification Item Numbers and Descriptions
- 1. DOC-100 – Final Inventory of CCTV Equipment

- a. Verify that all equipment has been delivered as defined in the project documentation.
2. DOC-101 – Approval of Samples
 - a. Verify that samples of all equipment to be used as defined in the project documentation have been submitted for approval.
3. DOC-102 – Delivered Product Against Samples
 - a. Where samples of products have been required for approval, verify that the products that are delivered are the same and of the same quality.
4. DOC-104 – Consultant’s Testing
 - a. Verify that any consultant’s testing requirements defined in the project documentation have been performed and approved.
5. DOC-105 –Contractor’s Testing
 - a. Verify that any contractor’s testing requirements defined in the project documentation have been performed and approved.
6. DOC-106 – Integrator’s Testing
 - a. Verify that any integrator’s testing requirements have been performed and approved as defined in the project documentation.
7. DOC-107 – Manufacturer’s Testing
 - a. Verify that any manufacturer’s testing requirements defined in the project documentation have been performed and approved.
8. DOC-108 – Owner’s Testing
 - a. Verify that any owner’s testing requirements defined in the project documentation have been performed and approved.
9. DOC-109 – Third-Party Testing
 - a. Verify that any third-party testing requirements have been performed and approved as defined in the project documentation.
10. DOC-110 – Substantial/Practical Completion
 - a. Verify that a conditional acceptance of the project has been issued by the owner or owner’s representative, acknowledging that the project or a designated portion is substantially/practically complete and ready for use by the owner, however some requirements and/or deliverables defined in the project documentation may not be complete.
11. DOC-111 – As-Built Drawings Complete
 - a. Verify that a complete set of accurate as-built drawings indicating all CCTV devices, CCTV device locations, mounting details, system wiring and cabling interconnects, and all other details has been provided as defined in the project documentation.
12. DOC-113 – Control System Test Reporting

- a. Verify that the control system test report has been completed and issued as defined in the project documentation.
 - 13. DOC-114 – Final Commissioning Report and System Turnover
 - a. Verify that the final commissioning report has been completed, issued to the proper entity, and accepted as defined in the project documentation.
 - 14. DOC-115 – Required Closeout Documentation
 - a. Verify that a complete set of as-built system documentation has been provided as defined in the project documentation.
 - 15. DOC-116 – Software Licensing
 - a. Verify that the usage and ownership rights have been assigned as defined in the project documentation.
 - 16. DOC-117 – User Manuals
 - a. Verify that manufacturer’s user manuals are delivered to the owner in a format defined in the project documentation (e.g., binders, PDFs), or dispose of the manuals in a responsible manner (recycling) if the owner specifies that they do not wish to receive the manuals.
 - b. Integrator- or programmer-created manuals and documentation shall be delivered to the owner in a format defined in the project documentation.
 - 17. DOC-118 – Video System Test Reporting
 - a. Verify that the video system test report has been completed and issued as defined in the project documentation.
 - 18. DOC-119 – Warranties
 - a. Verify that all warranties are activated and that all warranty details have been passed to the owner as defined in the project documentation.
 - 19. DOC-120 – Final Acceptance
 - a. Verify that a final acceptance of the project has been issued by the owner or owner’s representative, acknowledging that the project is 100% complete, that all required deliverables, services, project-specific verification lists, testing, verification and signoffs have been received, and that all requirements defined in the project documentation have been satisfied and completed.
- G. Electrical Reference Verification Item Numbers and Descriptions
- 1. ELEC-100 – CCTV Equipment Connected to Proper Circuit
 - a. Verify that all CCTV equipment is powered from the designated power circuit and outlet as defined in the project documentation. No additional (non-CCTV) equipment should be connected unless permitted in the project documentation.
 - 2. ELEC-101 – Grounding/Earthing
 - a. Verify that all elements of the CCTV system are correctly bonded to an electrical ground/earth in accordance with the requirements of the regulatory authority and as defined in the project documentation.
 - 3. ELEC-102 – Mains Voltage Sub-Distribution Integrity

- a. Verify that all electrical sub-distribution systems provided by the contractor in equipment racks, consoles, and similar structures meet local regulatory requirements for electrical integrity.
 - 4. ELEC-103 – Power Sources
 - a. Verify that the sources of mains voltage AC power to be used for the supply of CCTV equipment are correct as defined in the project documentation and have been tested to the outlet in accordance with local electrical standards.
 - 5. ELEC-105 – UPS Operation
 - a. Verify that the uninterruptible power supply (UPS) is performing to the specifications as defined in the project documentation.
 - 6. ELEC-106 – DC Power Distribution
 - a. Verify that all DC powered devices are receiving the proper voltage and current for normal operation.
 - 7. ELEC-107 – Power Loss Recovery
 - a. Verify that the CCTV systems resume normal operation on the restoration of power following a hard electrical power outage. Power loss recovery shall include verification of the resumption state on power recovery. Resumption state shall be the control system start-up condition/start page (where applicable) and resetting all devices to a known state as defined in the project documentation.
- H. Operations and Support Reference Verification Item Numbers and Descriptions
 - 1. OP-100 – Software
 - a. Verify that all control programming code, configuration files, and any other associated software have been provided as defined in the project documentation.
- I. Physical Environment Verification Item Numbers and Descriptions
 - 1. PHYSE-101 – Human Factors, Usability, and Ergonomics
 - a. Verify that ergonomics and usability elements for system users are installed and configured as defined in the project documentation.
 - 2. PHYSE-104 – Backing/Blocking/Framing
 - a. Verify that installed backing, blocking, and framing meets project documentation requirements and industry standards for installation means and methods.
 - 3. PHYSE-105 – Clean Building Handover
 - a. Verify that the area is clean, free of dust, and suitable for equipment installation and that no further work is planned that will release contaminants into any CCTV equipment area.
 - b. Verify that the area released is isolated from any areas not yet released.
 - 4. PHYSE-106 – Coordinated Construction Elements
 - a. Verify that the elements (including but not limited to spatial requirements and building services) required by the CCTV system that are coordinated with other disciplines have been provided as defined in the project documentation.
 - 5. PHYSE-107 – Device Enclosures

- a. Verify that device enclosures accommodate the intended device and that all necessary environmental controls (e.g., heating, cooling, humidity) are incorporated into the enclosure as defined in the project documentation.
 - 6. PHYSE-108 – Finishes
 - a. Verify CCTV equipment, furniture, fixtures, and accessories against the project documentation.
 - 7. PHYSE-109 –Wall Boxes/Ceiling Boxes
 - a. Verify that installed wall and ceiling boxes meet project documentation and regulatory authority requirements.
 - 8. PHYSE-112 – Structural Mounting
 - a. Verify configuration and compatibility of structural accommodations and all mounting hardware based on the intended application. All equipment mounting hardware shall be installed in the manner specified by the hardware manufacturer.
 - 9. PHYSE-113 – Protection of Installed Equipment
 - a. Verify that all elements of the CCTV system are free of damage.
 - 10. PHYSE-114 – Accessibility
 - a. Verify that all systems are accessible in accordance with regulatory requirements.
- J. Physical Installation Reference Verification Item Numbers and Descriptions
- 1. PHYSI-100 – Cable Containment/Conduit
 - a. Verify that installed containment/conduit capacity and routes meet project documentation requirements, industry standards, and regulatory requirements for installation means and methods.
 - b. Verify that installed containment/conduit is serviceable and free of contaminants.
 - 2. PHYSI-101 – CCTV Rack Air Flow and Temperature Performance
 - a. Verify that the CCTV rack(s) provides the air flow as required in the project documentation.
 - b. Verify that the temperature in the CCTV rack has been measured and is within tolerances defined by manufacturers' guidelines.
 - 3. PHYSI-102 – Equipment Security
 - a. Verify that equipment is secured as defined in the project documentation.
 - b. Verify that all security systems, devices, and manufacturer security accessories are installed and verified to be operating as defined in project documentation.
 - c. Verify that keyed devices have been keyed as defined in the project documentation and devices requiring configuration have been configured as defined in the project documentation and are verified to be operating within specification.
 - 4. PHYSI-103 – CCTV Equipment Labeling
 - a. Verify that all CCTV equipment has been labeled in accordance with the requirements of the project documentation. All labeling must be consistent, durable, accurate, and visible without dismantling of sub-assemblies.

5. PHYSI-104 – Plumb and Level/Square
 - a. Verify that all CCTV equipment has been installed, aligned, or angled correctly as defined in the project documentation. Level and plumb are the default requirement unless particular angles or other alignments are defined in the project documentation.
 6. PHYSI-105 – Site Security
 - a. Verify that all elements of the CCTV system are free from loss, damage, or tampering.
 7. PHYSI-106 – CCTV Equipment Location
 - a. Verify that CCTV equipment is installed at the location and/or in the rack or enclosure as defined in the project documentation. Equipment is installed per the elevation or other specification provided by the project documentation or the manufacturer's specification.
 8. PHYSI-107 – CCTV Rack Cleanliness
 - a. Verify that all components installed in CCTV equipment racks are free from dirt, dust, water, or any other element that would compromise the performance and/or longevity of the CCTV system.
 9. PHYSI-108 – Non-End-User Controls Protection
 - a. Verify that installed items with user-facing controls that are not intended for end-user access have been covered, disabled, or otherwise secured to prevent end-user operation.
 10. PHYSI-109 – Optical Components Cleanliness
 - a. Verify that all optical components, such as lenses and mirrors, are free from dirt, dust, damage, or markings that would compromise the optical performance of those system components.
 11. PHYSI-110 – Handling of Accessories Otherwise Undefined
 - a. Verify that all items that are pre-packaged with primary system equipment but have no documented/planned use in the CCTV system(s) are managed in accordance with the project documentation.
 12. PHYSI-111 – Turnover of Accessory System Elements
 - a. Verify that any equipment that may be considered portable and/or otherwise not specifically incorporated into the installed CCTV system(s) has been set up, configured, and tested.
- K. Serviceability Reference Verification Item Numbers and Descriptions
1. SERV-100 – Access Panels
 - a. Verify that any access panels that have been installed to provide access to any type of CCTV equipment are properly sized and positioned as detailed in the project documentation.
 2. SERV-101 – Ability to Maintain and Service Equipment

- a. Verify that all equipment is accessible and capable of being maintained, serviced, cleaned, or adjusted, as necessary.
 - b. Verify that all equipment requiring regular cleaning or maintenance is accessible without requirement for special equipment or tools that would disrupt the normal use of the facility and systems therein.
3. SERV-102 – Input and Output Panel Accessibility
- a. Verify that all input and output panels are accessible and meet all requirements for user access and placement.
4. SERV-103 – Rack Clearance
- a. Verify rack placement and use for physical stability in accordance with the project documentation and regulatory authority.
- L. Acknowledgement of Conformance to the Requirements

ACKNOWLEDGMENT OF CONFORMANCE TO THE REQUIREMENTS SHALL INCLUDE THE FOLLOWING WRITTEN STATEMENT, AUTHORED AND SIGNED BY THE SYSTEM VERIFIER, STATING THAT ALL REQUIREMENTS OF THIS SECTION HAVE BEEN COMPLETED, THE DATE OF COMPLETION, AND THAT THE HANDOVER OF THE COMPLETED, VERIFIED SYSTEM IS FINALIZED.

“THE SYSTEM VERIFIER ACKNOWLEDGES THAT THE PERFORMANCE OF THIS CCTV SYSTEM HAS BEEN VERIFIED IN CONFORMANCE WITH ALL REQUIRED PROCESSES AND CONTAINS ALL REQUIRED ELEMENTS AS DOCUMENTED WITHIN THIS SECTION.

	SYSTEM VERIFIER	DATE
3.4	FINAL ADJUSTMENTS AND ACCEPTANCE TESTS	
A.	Upon approval of the contractor's test report, and at a time set by the Owner or Owner's authorized representative, perform final system adjustments and acceptance tests. Provide all labor, material, tools, and measurement equipment necessary for these tests and adjustments, including the test equipment and material specified in Article 1.1, except as otherwise specified.	
B.	The contractor's representatives performing these tests shall be thoroughly familiar with all details of the system and shall include the field supervisor in overall charge during the installation work.	
C.	Budget eight (8) working hours for the performance of these tests and adjustments. If final acceptance is delayed beyond this period because of installation not in accordance with these specifications, pay for all additional time and expenses of Owner-designated observers during any resultant extension of the acceptance testing period.	
D.	Adjustments: Adjust the system as instructed by the Consultant.	

3.5	TRAINING	
A.	The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.	
B.	During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.	

- C. After the completion of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS, provide on-site training to the end-user to instruct them on the proper use of each system, including:
1. Explain operation of control systems and overall function of installed systems to staff selected by the Owner as "requiring general instruction".
 2. Explain operation of control systems, set-up, and operation of individual pieces of equipment, functions of overall systems, and rudimentary service guidelines to staff selected by the Owner as "requiring technician level instruction".
 3. If requested by the Owner, record these training sessions, and provide them to the Owner for future reference by the Owner's personnel.
 4. After successful training, a repair sequence (schedule of responsibility, response tree, etc.) should be established with any "technician level" staff, designated by the Owner as responsible for CCTV systems operation and maintenance, to expedite service calls. D. Separate from the bid response quotation; provide an hourly cost for additional training.

3.6 WARRANTY

- A. Unless otherwise described in Division 01, provide for the warranty of the delivered system under the following terms and exclusions:
- B. Basic Warranty
1. Basic Warranty provided by the Integrator shall include repair or replacement for one year from date of Final Acceptance on all CCTV Systems Equipment provided (including products having a manufacturer's warranty of less than one year) and all Integrator workmanship. Basic Warranty shall be provided at no additional cost, except in case of obvious abuse.
 2. During the Basic Warranty period the Integrator shall:
 - a. Provide telephone support within 4 hours of a call requesting service.
 - b. Provide emergency service: Within 24 hours of a call requesting service not corrected by telephone support, restore the system to operation, replacing defective materials and repairing faulty workmanship. Make temporary repairs and provide loaner equipment at no charge if defective materials cannot be permanently replaced or repaired within this 24-hour period. Repair or replace faulty items within 72 hours of on-site service or within manufacturers' specific repair program whichever is quicker.
 3. Integrator shall not involve the Owner with removing, re installing equipment, shipping, or receiving equipment being repaired under Basic Warranty, nor shall the Owner be responsible for any shipping or freight charges associated with any item under warranty.
 4. The Owner shall be copied with all paperwork related to all warranty work during the Basic Warranty period.
 5. The Basic Warranty period will commence no sooner than the date of first beneficial use by the Owner and no later than the date of contract closeout.
 6. Paint and exterior finishes excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
 7. The terms of individual equipment manufacturers' warranties are not diminished by the minimum warranty provisions specified above.
- C. Preventative Maintenance

1. Within the term of the one-year Basic Warranty period the Integrator shall provide, at no additional cost, periodic Preventative Maintenance on the installed CCTV System to ensure proper ongoing maintenance and operation.
 2. A minimum of four (4) Preventive Maintenance visits shall be provided.
 3. Preventative Maintenance shall include, but not be limited to, the following:
 - a. Adjustments to camera configurations
 - b. Reviewing control system functionality
 - c. Any other maintenance and adjustments necessary to ensure that the CCTV System is in proper working order
 4. Any problems or issues noted by the users or other Owner representatives shall be documented and completely resolved at each of the scheduled visits.
 5. Preventative Maintenance Schedule
 - a. 90 days (± 15 days) after the commencement of the Warranty Period.
 - b. 180 days (± 15 days) after the commencement of the Warranty Period.
 - c. 270 days (± 15 days) after the commencement of the Warranty Period.
 - d. 20 days (± 10 days) before the end of the Warranty Period.
- D. Extended Warranty
1. The Integrator may elect to propose to the Owner the offer of Extended Warranty coverage for the CCTV Systems. Extended Warranty shall be any optional warranty services offered by the Integrator that expand on and complement the Basic Warranty coverage required by this Specification. Any provisions of Extended Warranty coverage shall not release the Integrator from responsibility for performance of all requirements under the Basic Warranty coverage.
- E. Software Support
1. The Bidder shall also offer an annual Software Maintenance contract. This shall cover all software provided as part of this system and/or written for this system and shall include routine upgrades to applications and operating systems. The Software Maintenance contract shall commence immediately after expiration of the warranty period and continue for [three] years. Maintenance visits will be [four] times per year and shall be scheduled to coincide with the periodic system maintenance of the system.

END OF SECTION

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SECTION 28 26 00

EMERGENCY CALL BOXES

PART 1 GENERAL

1.01 DESCRIPTION

- A. This specification section covers the furnishing and installation of Emergency Phones at the Los Angeles Community College District (LACCD).
- B. The contractor shall furnish and install hardware devices, mounting brackets, power supplies, switches, controls, and other components of the system as shown and specified.
- C. Furnish and install outlets, junction boxes, conduit, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26, Electrical.

1.02 PRECEDENCE

- A. Obtain, read, and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.03 GENERAL CONDITIONS

- A. In accordance with Section 28 00 00, Security Systems Basic Requirements

1.04 RELATED WORK

- A. In accordance with Section 28 00 00 Security Systems Basic Requirements
- B. In accordance with Section 28 04 00, Security System General Requirements.

1.05 OPERATING AND MAINTENANCE MANUALS

- A. In accordance with Section 28 00 00 Security Systems Basic Requirements.

1.06 SERVICE AND MAINTENANCE

- A. In accordance with Section 28 00 00 Security Systems Basic Requirements

1.07 TRAINING

- A. In accordance with Section 28 00 00 Security Systems Basic Requirements

1.08 WARRANTY

- A. In accordance with Section 28 00 00 Security Systems Basic Requirements

1.09 TECHNICAL REQUIREMENTS, EMERGENCY PHONE SYSTEM

- A. General The following information is provided to establish the required system performance for a complete operating Emergency Phone System for the [site and/or facility]. Some functions and performance requirements noted herein are supported and supplied by existing systems in concert with new equipment which shall be provided by the Contractor under this scope of work. The contractor shall provide

equipment, wiring, and programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.

1. Components provided under this scope of work shall be compatible with the UC communications phone system and connected to the EACS portion of this project.
 2. The contractor shall be responsible for providing equipment and connections to achieve specified system performance.
- B. Purpose: The system is designed to allow communication from the device to the programmed responding location allowing the responder to assist the caller.
1. Attributes
 - a. General
 - 1) Emergency phones with visual locating devices are located in the elevator lobbies.
 - b. Elevator Lobby Emergency Phones
 - 1) Emergency phones utilize the campus phone system dialing automatically to call a monitoring location.
 - 2) Each device shall be equipped with a red button identifying the location of activation.
 - 3) Each device shall be equipped with a single pushbutton which will activate the calling function.
 - 4) Emergency phones shall be provided in a wall-mounted configuration, as indicated on the plans.

PART 2 PRODUCTS

2.01 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified and compatible with the existing LACCD Emergency Phone System system. Considerations may include but shall not be limited to functional, physical, aesthetic, and/or interface aspects. The Owner shall be the sole judge of whether a submitted substitution is deemed to be "equivalent" to that specified. The contractor may not use contractor proprietary interface modules for connections between the field and controller.
- B. Equipment shall have a UL-listed mark on the product.
- C. Assemblies shall be approved by a recognized agency acceptable to the City of Los Angeles.

2.02 EMERGENCY PHONE

- A. Provide Emergency Phones in the following configurations. Phones shall incorporate communication compatible with the Owner's communications system.
1. Interior Wall Phone
 - a. Provide "Talk-A-Phone" model AOR-IP-CSE Phone

- 1) Stainless Steel faceplate
- 2) Single push button activation
- 3) LED indicator for hearing impaired
- 4) Built-in auto-dialer
- 5) Auto-Answer
- 6) Second number dial on the first number no answer
- 7) UL listed

b. Provide [indicate] surface/flush mounting enclosure to match the phone.

2.03 WIRE AND CABLE

- A. General: Cables that are not installed in conduit shall be a version of the specified cable rated for use in plenums.
- B. System cable: Provide cable as shown below, or as recommended by the Manufacturer.
 1. Emergency Phone: Category 6A UTP cable by Windy City, or equal.
- C. Cable installed below grade shall be rated for immersion in water.
- D. Refer to the LACCD Telecommunications/IT standards for termination and routing requirements for the telecommunications cable.

PART 3 EXECUTION

3.01 GENERAL

- A. In accordance with Section 28 04 00, Security System General Requirements.

3.02 EMERGENCY PHONE INTEGRATION

- A. Provide access control system integration equipment, and software programming, in accordance with Section 28 13 00, Access Control. In addition, provide specific integration schemes noted.

3.02 GROUNDING PROCEDURES

- A. Provide grounding of all systems and equipment in accordance with Section 28 04 00, Security System General Requirements.

3.03 WIRE AND CABLE INSTALLATION PRACTICES

- A. Provide wire and cable installation in accordance with Section 28 05 13, Security System Cabling Requirements.

3.04 START-UP RESPONSIBILITY

- A. Provide start-up services for all systems and equipment in accordance with Electronic Safety and Security, Section 28 05 00.

3.05 PRELIMINARY INSPECTION AND TESTING

- A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 00 00.

3.06 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Provide performance testing and adjusting of systems and equipment in accordance with Testing and Commissioning, Section 28 00 00.
- B. Emergency Phone
 1. Verify phone indicator is on
 2. Verify phone indicator flashes when activated.
 3. Verify voice communication with called station
 4. Verify visual indicator is on during normal operation
 5. Verify visual indicator strobe function is activated during use.

3.07 BURN-IN PERFORMANCE PERIOD

- A. Provide a burn-in performance period to demonstrate the stability of the system, in accordance with Testing and Commissioning, Section 28 00 00.

3.08 COMMISSIONING AND VALIDATION

Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.09 TRAINING

- A. Provide training requirements of Security System General Requirements Section 28 00 00

3.10 FINAL PROCEDURES

- A. Perform final procedures in accordance with section 28 00 00, Security System General Requirements.

END OF SECTION

SECTION 28 26 05

RESCUE ASSISTANCE COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. The standards provided have been set forth for the Contractor, installer to follow for any future projects and or renovations. For a complete list of material for each campus where work is performed, please refer to BuildLACCD campus standards web site:

<http://www.build-laccd.org/contractors-bidders/standards-guidelines/quick-search-results?type=guidelines&category=13>

These standards are provided to serve as a guideline for contraction project to be completed correctly per latest district requirements. Contractors are to confirm any discrepancies between their scope of work and these specs prior to start of any project. After contractor accepts any bid, the contractor shall be responsible to provide their work per the Set Standards.

- B. The Area of rescue system shall be provided and installed per latest ADA and LACCD district standards for buildings of 2 stories or more. The purpose of providing such system is to assist individuals in case of emergency where these cannot leave a given floor.
1. Furnish all labor, materials, tools, equipment and services for a complete area of Rescue Assistance Communication System as indicated in Contract Documents and as required by the American Disabilities Act (ADA).
 2. Completely coordinate with work of all other trades.
 3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.02 QUALITY ASSURANCE

- A. Transistors, capacitors, resistors, integrated circuits and other components shall not be operated to exceed their rated values. Design systems for 24 hour continuous operation.

1.03 SUBMITTALS (REFER TO SECTION 26 05 00)

A. Product Data:

1. Technical data on each product including finishes.
2. Description of system operation.
3. Riser diagrams and system data.
4. Equipment design considerations for future expansion when indicated.
5. Materials list and backbox schedule (including unique backboxes).

B. Project Data:

1. Operating and Maintenance Data

- a. Factory-prepared operation and service manual for each system.
- b. Include operation details, schematics, wiring diagrams, color coding, terminal numbers and component values for printed-circuit boards.
- c. Owner Instruction Reports: Refer to Section 26 05 00.

1.04 OPERATION

- A. General: Provide two way audible/visual communication between a master annunciator station and the area of refuge, area of rescue assistance and/or elevator landing communication stations.

1.05 SYSTEM OPERATION

- A. With the system in standby mode, all LED's are extinguished and no alarms are heard. A momentary actuation of a Rescue Assistance Call Switch will illuminate the switch and sound a local tone confirming activation. Simultaneously, the associated LED at the Rescue Assistance Annunciator Panel will illuminate and initiate a repeating audio alarm.
- B. The Fire Department, or appropriate local authority, can acknowledge receipt of the call by momentarily depressing the associated switch on the Rescue Assistance Annunciator Panel. This will flash both the annunciator LED and the calling stations LED. In addition, a repeating audible signal will begin at the calling station indicating that help is on the way. Actuating the acknowledge switch a second time will cancel the call and return that zone to the standby mode. The repeating audio alarm at the annunciator panel will continue until all calls have been acknowledged or cancelled.
- C. A yellow LED will illuminate at the remote annunciator panel if there is a line fault.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cornell #A4200 Series.
- B. Housing Devices, Inc. #ADA-1000 Series.

2.02 EQUIPMENT

- A. Master Remote Annunciator shall consist of a modular arrangement of intercom 'ON' and flashing red zone LED indicators in multiples of four zones. The annunciator panel shall include a "push to talk" and an audible alarm device with a sound level of not less than 90 dB at 30 cm. The panel shall be constructed of .125" thick clear anodized aluminum. Permanent silk-screened zone designations shall be provided on the panel as well as a designation strip. Backbox and panel dimensions will vary depending upon system configuration and number of zones required.
- B. Power source shall be a transformer rated for total system devices with an optional battery-backed DC power supply with battery supply for continuous operation of 15 90 minutes 4 hours.
- C. Wiring to call station shall be supervised. In the event of a wire fault, a yellow LED zone indicator on the annunciator shall illuminate and a repeating audio alarm shall sound.
- D. Remote Rescue Assistance Call Station shall consist of one momentary switch with LED, incandescent lamp not acceptable, and one audible alarm device with a minimum sound level of not less than 70 dB at 30 cm all mounted on a one gang stainless steel plate. Permanent silk-screened designations shall be provided on the plate.

- E. Wiring shall consist of 22 gauge (minimum) wire or as indicated on drawings. Three conductors plus one shielded pair are required between each Rescue Assistance Call Station and the annunciator panel not to exceed 3,000 feet. Power wire shall be 12 gauge (minimum). Two conductors are required between the power supply or transformer and the annunciator panel.

2.03 INSTALLATION

- A. Install all components and complete system as indicated and in accord with manufacturer's recommendations and instructions.
- B. Install all wiring in conduit from wall outlet to corridor cable tray above accessible corridor ceiling.
- C. Contractor is to provide and install a typewritten list in a Plexiglas frame permanently fastened to the wall next to the Master Rescue Assistance Annunciator Panel to indicate the building location of each of the remote area of Rescue Assistance Call Stations and to which annunciator zone and LED they correspond.
- D. Contractor is to provide a typewritten list of area of Rescue Assistance Communication Instructions in a Plexiglas frame permanently fastened to the wall next to each remote switch and the annunciator panel to explain the operation of the system.

2.04 SYSTEM TESTING

- A. Test each component and complete system for proper operation, including all modes. Perform correctional work when required. Testing shall be done in the presence of the Owner's Representative(s).

2.05 OWNER PERSONNEL INSTRUCTION

- A. Instruct maintenance and staff personnel in complete operation, including actual staff use of system, by authorized distributor personnel. Arrange timing of the session in writing to best coordinate with Owner's working hours. Allow four (4) hours of training. This training session shall be videotaped by the Contractor.

2.06 WARRANTY SERVICE

- A. Warrant all Work of this Section to be free from defects in materials and workmanship for a minimum of 1 year from the date of Owner acceptance of the Work of this Section.
- B. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty may be voided. In such cases, provide a warranty equivalent to that of the original manufacturer.
- C. Response Time: Provide a qualified technician familiar with the system at the Project Site within 12 hours after receipt of a notice of malfunction. Provide the Owner with the telephone number attended 8 hours a day, 5 days a week, and an answering service or equivalent facility attended 24 hours a day, 7 days a week, to be called in the event of a malfunction. Provide repairs at no expense to the Owner and at the Owner's request, alternate facilities, services and systems for the duration of the repairs to any defective work of this Section. Provide a complete and operational System, within 48 hours after notification of a malfunction.
- D. All work requested due to warranty issues shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.
- E. The Contractor shall use qualified service personnel to respond to all warranty issues or calls.

- F. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute system equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts and personnel to and from the Project Site.

END OF SECTION

SECTION 28 31 01

FIRE ALARM AND DETECTION SYSTEMS (ADDRESSABLE)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire Alarm and Detection Systems
- B. Campus Fire Alarm Network Connections
- C. One-way emergency communications system with voice notification within-building, wide- area, and distributed recipient coverage (Mass Notification)

1.02 RELATED WORK

- A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with a minimum of ten years experience.
- B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with a minimum of five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level3. This person's name and certification number shall appear on the start-up and testing reports.

1.04 REFERENCES

- A. ASME A17.1 - Safety Code for Elevators and Escalators
- B. NFPA 20 - Standard for Centrifugal Fire Pumps
- C. NFPA 70 - National Electrical Code
- D. NFPA 72 - National Fire Alarm and Signaling Code
- E. NFPA 101 - Life Safety Code
- F. UL 2017 – General Purpose Signaling Devices and Systems
- G. UL 2572 - Control and Communication Units for Mass Notification Systems
- H. California Fire Code (CFC)

1.05 SUBMITTALS

- A. Provide product catalog data sheets as shop drawings.
 - 1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.
 - 2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
 - 3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
- B. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- C. Provide manufacturer letter and certification indicating proposed method of fire alarm system monitoring and campus system interface.
- D. Provide installation and maintenance manuals under provisions of Section 26 05 00.
- E. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- F. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- G. Voice Alarm Communication System: Submit equipment rack or console layout, grounding schematic, amplifier power calculations, and wiring diagram.
- H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.
- I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.
- J. All fire alarm devices are to be tested to NFPA 72E and report delivered to the Facilities Director prior to acceptance of system.
- K. Fire alarm provider shall hire a low voltage contractor to install the system. Installer must be certified for the system being installed. Contractor must provide proof of certification.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
 - a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.

- b. Notification appliances: Speakers, speaker strobes, and strobes.
 - c. In addition to the above, an additional 5% of component parts shall be provided as added stock.
- 2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet [minimum of one (1) set each] and shall turn over to the Owner upon completion.
 - 3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."
 - 4. Trouble shooting and cleaning kits shall be provided.

1.07 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 72.
- C. Conform to requirements of CBC and CFC.
- D. Conform to requirements of Americans with Disabilities Act (ADA).
- E. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.08 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, voice evacuation equipment, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Integrating the existing fire alarm system: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to integrate the existing fire alarm system and campus network with the new fire alarm system. This includes, but is not limited to, additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system and network shall be integrated with the new fire alarm system such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre- construction conditions unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point.
- D. The entire system shall be annunciated at any annunciation location.

- E. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
- F. Campus Ethernet IP Network: A complete fire alarm and mass notification network shall be provided based on the Campus Standards on which the project is located. The network shall be Class X, that shall be able to operate with any single break and self-restoring network communications. Each building shall contain an independent building fire alarm / voice communications system, with full command and control from the campus command center. In no case shall read only network annunciation be acceptable as the only networking function.
- G. Voice Communication: The facility shall have an emergency voice alarm communication system. The digitized recorded voice message shall notify occupants that a fire condition has been reported. Emergency manual voice override shall be provided.
- H. Firefighter Phone System: A two-way talk path shall be provided for the fire department's use from the voice command center to the secondary fire alarm attack entrances, elevator lobbies, primary and backup power rooms and the entrance to all enclosed stairways.
- I. Emergency Communication System (ECS): A system capable of reproduction of prerecorded, synthesized, or live messages with voice intelligibility to indicate the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action. The system shall provide alerting in the building, wide-area notification on the campus and interface with distributed recipient mass notification system.
- J. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- K. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
- L. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
- M. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.
- N. Fire alarm systems and components shall be of the latest technology.
 - 1. The model shall be the latest version put out by the manufacturer.
 - 2. Parts must be readily available for five (5) years.
 - 3. System shall be supported by the manufacturer for five (5) years.
- O. System must have the capability to be viewed remotely. The remote viewing shall be Web based.
- P. Any contractor that modifies the fire alarm system data base takes full responsibility for the entire fire alarm system data base.

1.09 PROJECT RECORD DOCUMENTS

- A. Include location of end-of-line devices.
- B. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- C. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.
- D. Contractor shall develop and submit a campus map showing the entire system, including the location of all devices.
- E. Contractor shall provide a list of the location of all devices. In addition, all fire alarm devices shall be tagged.
- F. System be integrated with college drawings and match current room number signage.
- G. Copies of the video training shall be supplied.
- H. The Fire Alarm System must pass commissioning prior to acceptance.
- I. Four (4) hours of in-person training shall be provided.

1.10 OPERATION AND MAINTENANCE DATA

- A. Include operating instructions, and maintenance and repair procedures.
- B. Include results of testing of all devices and functions.
- C. Include manufacturer's representative's letter stating that system is operational.
- D. Include the CAD floor plan drawings.
- E. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.11 DOCUMENT STORAGE CABINET

- A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard size business card with service contact information. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.
- B. The cabinet shall be red in color with an identification label reading "FIRE ALARM DOCUMENTS". Refer to Identification Section 26 05 53. The cabinet shall be lockable.
- C. The final version of the system database program shall be stored within the cabinet.

1.12 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.

- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

1.13 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT

- A. Provide cost to furnish service, inspect, and test all devices of the fire alarm system per the requirement of NFPA for one (1) year, starting one year after the Date of Substantial Completion. Submit written reports of inspection testing per NFPA 72, Chapter 14.
- B. Provide an alternate cost for a complete inspection/testing and service/maintenance contract for the fire alarm system for one (1) year two (2) years, starting one year after the Date of Substantial Completion. Submit sample contract terms and conditions for review with shop drawings.
- C. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS BY COLLEGE – NO SUBSTITUTIONS

- A. City – Edwards EST
- B. East – Edwards EST
- C. Harbor – Edwards EST integrated into PA system
- D. Mission – Notifier
- E. Pierce – Silent Knight
- F. Southwest – Simplex
- G. Trade Tech – Edwards EST
- H. Valley – Simplex
- I. West – Siemens

2.02 FIRE ALARM CONTROL PANEL (FACP)

- A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
- B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:

Minimum Total Addressable Points: 250 500 2000

Minimum Total SLC loops

(including board, ready for field connections): 1 2 4 6 8 10

Panel Expansion Capability, Minimum Total SLC loops: 1

Minimum Node capacity for Network System: 10

C. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:

1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.

D. Interconnection of Multiple Fire Alarm Panels:

1. The pathways of interconnected fire alarm panels or systems shall be as follows:
2. Pathway Class X: Circuits with redundant pathways capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a two-hour rated enclosure.
3. Fire Alarm System shall be connected to the central panel.
 - a. No stand-alone systems.
 - b. All systems and stations must register on the main panel.
4. System shall be installed with a fiber network.
5. New buildings must be integrated into the existing campus system.
6. Provision shall be made for future interconnection and monitoring of new systems at the LACCD SOC. Proposed future interconnection methodology shall be clearly stated on the fire alarm system design submittal documentation.

E. Central Processing Unit:

1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.
3. All power for the unit shall be supervised and supplied by the FAP.

F. Display:

1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.

3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
 4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.
 5. System shall indicate if a fire damper is open or closed, and the location of the damper, on the fire alarm display.
- G. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.
- H. Serial Interface Board: The board shall provide interfaces to a printer, LCD display and other monitoring devices through RS-232 connections. The minimum operational distance between the board and the peripheral devices shall be 500 feet. Up to three (3) RS-232 outputs shall be supported.
- I. Power Supply:
1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated emergency branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 05 53.
 2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
 3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
 4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.
- J. Surge Protection:
1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 05 53. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
 2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

K. Digital Communicator:

1. Provide dual phone line interface capable of fire alarm notification to the local fire department, fire protection agency, or monitoring service. Communicator shall report in SIA and most major communication formats, with the capability of transmitting each device address point in a format compatible with the central station receiver.
2. Communicator shall be fully supervised and shall operate on loop start phase lines ahead of the building PBX system.
3. Communicator shall be FCC registered. Contractor shall provide two RJ31X jacks. Contractor to provide connection of communicators to Owner's telephone system.
4. Approvals: UL listed - UL 864/NFPA 72, FM approved.
5. The communicator shall be provided integral to the fire alarm panel as furnished by the fire alarm panel manufacturer. If the panel construction requires a separate unit, the unit shall be as manufactured by Silent Knight, Ademco, or fire alarm panel manufacturer approved equal.

L. Digitized Voice Command Center (VCC):

1. The Digitized Voice Command Center (VCC) shall contain all equipment required for all audio control, firefighter phone system control, signaling, and supervisory functions. This shall include digital voice units and microphones.
2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised single channel automatic digitized voice evacuation system with manual emergency voice communication system.
 - b. Audibly and visually annunciate the active or trouble condition of every signal circuit and firefighter phone circuit.
 - c. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
 - d. Provide all-call activities through activation of a single control switch.
 - e. Provide automatic, digitally recorded voice messages and tones.
3. Audio Amplifiers:
 - a. The audio amplifiers will provide a single channel audio power at 25/70 volts RMS for distribution to speaker circuits.
 - b. Provide multiple audio amplifiers mounted in the transponder or in the main fire alarm control panel, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
 - c. The audio amplifier shall include an integral power supply, and shall provide the following controls and indicators:
 - 1) Normal Audio Level LED
 - 2) Incorrect Audio Level LED
 - 3) Battery Trouble LED
 - 4) Amplifier Trouble LED
 - 5) Audio Amplifier Gain Adjust

- d. Includes audio input and amplified output supervision backup input.
4. Audio Message Generator (Digitized Voice):
- a. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a digitized voice message to all speakers in the building.
 - b. Actuation of any alarm initiating device shall cause a digitized message to sound over the speakers. The message shall be repeated four (4) times.
 - c. A built-in microphone shall be provided to allow paging through speaker circuits.
 - d. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control:
 - 1) All Call LED
 - 2) On-Line LED
 - 3) All Call Switch
5. Voice Messages:
- a. A pre-programmed custom digital voice message shall be used for notification appliance speaker circuits. The messages shall be approved by the Authority Having Jurisdiction (AHJ). Voice messages shall be from a male voice. The messages shall be provided in the multi-lingual language of the predominant building population.
 - b. Message shall be preceded by a tone and message shall be repeated four times until silenced.
 - c. Messages shall be annunciated by a single channel in all evacuation signal zones throughout the building.
 - d. Primary messages shall be annunciated in the zone of fire alarm and adjoining areas' evacuation signaling zones, and the secondary message in all other evacuation signaling zones.
 - e. Message shall be as shown in the following table. These messages are not intended to specify the exact wording required, but to specify the minimum information conveyed by the message:

Alarm Type	NAC Area	Preceding Tone	Message
Fire Alarm	Single Channel-all areas	Three Chimes	May I have your attention please? A fire emergency has been reported in the building. Proceed calmly to the nearest exit and leave the building immediately. Do not use the elevators. Use stairwells where necessary. Occupants that are unable to use stairways shall report to designated Areas of Rescue Assistance.
Fire Alarm	Dual Channel- Primary Message Area of alarm and adjoining evacuation signaling zones	Three Chimes	May I have your attention please? A fire emergency has been reported in the building. Please evacuate to a different area or floor of the building and await further instructions. Occupants that are unable to use stairways shall report to designated Areas of Rescue Assistance.
Fire Alarm	Dual Channel- Primary Message Area of alarm and adjoining evacuation signaling zones	Three Chimes	May I have your attention please? A fire emergency has been reported in the building. Proceed calmly to the nearest exit and leave the building immediately. Do not use the elevators. Use stairwells where necessary. Occupants that are unable to use stairways shall report to designated Areas of Rescue Assistance.
Fire Alarm	Dual Channel- Secondary Message All other evacuation signaling zones	Three Chimes	May I have your Attention please? A fire emergency has been reported in another area of the building. Please stand by for further instructions. Please do not use elevators
Test	All areas	One Chime	"May I have your attention please? May I have your attention please? This is a test of the building emergency alarm system. This is only a test."
All Clear	All areas	One Chime	"May I have your attention please? May I have your attention please? The reported emergency has been investigated and normal conditions have been restored. You may return to all areas of the building."

6. Speaker Circuit Control Switches/Indicators:
 - a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
 - b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.
 - c. Buttons shall be provided on the voice command center to manually activate all auxiliary messages. (i.e. all clear, severe weather, homeland security warning, custom message)

2.03 EMERGENCY TELEPHONE DEVICES

A. Portable Emergency Telephone Handset Jack:

1. Flush mounted on stainless steel plate at locations indicated on plans.
2. Insertion of the remote handset plug into a jack shall send a signal to the fire command center and shall sound a ring indication in the handset.

B. Fixed Emergency Telephone Handset:

1. Recessed telephone cabinet painted red and clearly labeled EMERGENCY TELEPHONE at locations indicated on plans.
2. Lifting of the handset cradle shall send a signal to the fire command center and shall sound a ring indication in the handset.

2.02 SIGNALING LINE CIRCUIT DEVICES

A. Smoke Detectors:

1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
2. Analog Ionization Type Sensor: Shall use the dual chamber ionization principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. Each smoke detector shall connect directly to an SLC loop.
4. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
5. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
6. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
7. A test means shall be provided to simulate an alarm condition.

8. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.
 9. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Recall, D=HVAC Control, SW=Stairwell, CR=Computer Room, SD=Smoke Dampers, DH=Door Hold Release, FD= Fire Door Release.
- B. Projected Beam Type Detectors:
1. This device shall utilize photoelectric analog smoke sensor technology. Provide with transmitter and associated receiver. Microprocessor-based detector shall provide a minimum of eight sensitivity levels, temperature and dirt compensation, and automatic gain control. Sensor to contain beam alignment adjustments and receiver calibration.
 2. Detector shall connect directly to an SLC loop or shall be provided with multiple monitor modules, as required, to connect to the SLC loop and for monitoring alarm and trouble output contacts. The detector shall be provided complete with all mounting hardware provided and installed where indicated on the drawings.
 3. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided.
 4. Provide with remote indicator panel providing LED indications of alarm and trouble.
- C. Duct Smoke Detectors:
1. Duct-type smoke detectors shall use the same analog photoelectric ionization sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
 2. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, the Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
 3. Provide a remote alarm LED indicator device if detector is not visible from a floor- standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.
- D. In-Duct Smoke Detectors:
1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
 2. Analog Ionization Type Sensor: Shall use the dual chamber ionization principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
 3. Low Flow Type: Listed for use in duct with 0-2000 feet per minute velocity.
 4. Each smoke detector shall connect directly to an SLC loop.

5. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided to match the duct application. Provide a two-piece head/base design.
 6. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
 7. Provide a remote LED indicator device mounted in ceiling directly below detector with a single-gang faceplate labeled: Duct Smoke Detector.
- E. Manual Pull Stations:
1. Manual stations shall match the description on the drawings (refer to the General Electrical Equipment Schedule). The stations shall be mounted where shown on the drawings and be provided with all necessary mounting hardware. Use surface mount only on precast concrete or structure.
 2. Addressable, single action with plastic breakrod, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering.
 3. Addressable, single action with plastic breakrod, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering. Provide device with clear Lexan tamper resistant cover with integral 9V battery powered alarm that sounds when shield is lifted.
 4. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
- F. Heat Detectors:
1. Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
 - a. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Shutdown.
 2. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
 3. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
 4. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
 5. Provide a remote LED indicator device if detector is not visible from a floor- standing position.
 6. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.

7. A test means shall be provided to simulate an alarm condition.

G. Carbon Monoxide/Heat/Smoke Combination Detector:

1. Multi-criteria sensor for photoelectrical smoke sensing, heat and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
2. The combined photoelectric smoke detection/heat/CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.
3. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.
4. The detector shall use only one address on the SLC.
5. CO sensor cartridge element shall be field replaceable.

H. Monitor Modules:

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2- wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
3. The module shall supply the required power to operate the monitored device(s).
4. The module shall provide address setting means using rotary decimal or DIP switches.

I. Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).
2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.02 NOTIFICATION APPLIANCE DEVICES

A. Device Color:

1. Wall Mounted: White housing with red lettering.

2. Ceiling Mounted: White housing with red lettering.
 3. WG subscript indicates wire guard is required.
- B. Visual Alarm Devices:
1. Wall mounted.
 2. Ceiling mounted.
 3. High intensity (candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
 - a. Candela Ratings: V1=15, V3=30, V7=75, VH=110, VS=177.
 4. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
 5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- C. Audio Horn Alarm Devices:
1. Wall mounted.
 2. Ceiling mounted.
 3. Sound Rating: 85 dB at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
 4. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.
 5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- D. Audio (Speaker) Alarm Devices - Wall Mounted:
1. Sound rating shall be dependent on the tap (wattage) setting. Tap settings shall be available in 3 dBA increments. A minimum of four (4) tap settings should be available to allow field adjustment of the sound output across a minimum range of 78 to 87 dBA, 400Hz to 4KHz (6 dBA cutoff) frequency range.
 2. Speakers shall operate on a 25V RMS system, unless otherwise noted on drawings.
 3. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice with voice intelligibility.
 4. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- E. Audio (Speaker) Alarm Devices - Ceiling Mounted:
1. 4" speaker, round housing, flush mounted (provide tile bridge where applicable).

2. Sound rating shall be dependent on the tap (wattage) setting. Tap settings shall be available in 3 dBA increments. A minimum of four (4) tap settings should be available to allow field adjustment of the sound output across a minimum range of 78 to 87 dBA, 400Hz to 4KHz (6 dBA cutoff) frequency range. Speakers shall operate on a 25V RMS system, unless otherwise noted on drawings.
 3. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice and background music with voice intelligibility.
 4. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- F. Combination Audio Horn and Visual Notification Device:
1. Wall mounted.
 2. Ceiling mounted.
 3. Combine horn and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
- G. Combination Audio (Voice) and Visual Notification Device:
1. Wall mounted.
 2. Ceiling mounted.
 3. Combine speaker and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
- H. Weatherproof Visual Notification Device:
1. High intensity strobe, square housing, 75 candela rating, suitable for wet locations. Provide with weatherproof back box.
 2. Mounting: Semi-flush wall.
 3. Conduit shall not be exposed.
- I. Weatherproof Audio/Visual Notification Device:
1. Electronic horn with high intensity strobe, square housing, 75 candela, suitable for wet locations. Provide with weatherproof back box.
 2. Mounting: Semi-flush wall.
 3. Conduit shall not be exposed.
- OR**
- J. Weatherproof Voice/Visual Notification Device:
1. Speaker with high intensity 75 candela rated strobe. 25 VRMS with a minimum of four (4) tap settings which shall allow field adjustment of the sound output across a minimum range of 78 to 87 dBA (UL 1480), 400 Hz to 4 KHz (6dBA cutoff) frequency range.
 2. Mounting: Semi-flush wall.

3. Conduit shall not be exposed.
- K. Mini-Horn Audio Notification Device:
1. Electronic horn.
 2. Mounting: single-gang flush wall.
- L. Emergency Communication Message Display (CMD):
1. LED illuminated text sign operating in response to fire alarm control panel inputs. Two independently illuminated text messages (ANNOUNCEMENT and EVACUATE). Messages shall be either static or flashing.
- 2.02 ELEVATOR SHAFT DAMPER CONTROL
- A. Smoke detectors in the hoistway or elevator lobbies shall open the elevator hoistway vent automatic damper upon detection of smoke.
- 2.03 NAC EXTENDER PANELS (NEP)
- A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC).
- B. Each NEP shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NEP provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.
- C. Power for each NEP shall be from a local 120 VAC emergency circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NEP from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device.
- D. Mounting: Surface.
- 2.04 ANNUNCIATION
- A. Color Graphics Network Annunciation System:
1. The annunciator shall provide custom color graphics displays for the control panel to annunciate the status of the panel and every peripheral device. It shall record and display system historical information on an LCD flat panel display.
 2. The annunciator shall have the ability to display a minimum of 256 custom screens and shall be fully field programmable. The fire alarm vendor shall develop screens from DXF or DWGCAD files provided by the Owner.
 3. Operator control shall be via an attached keyboard and mouse.
 4. The annunciator shall store all alarms, troubles and operator activity to an internal hard drive and shall have a capacity of 10,000 events without data loss.
 5. Events shall have a time and date stamp.
 6. Graphics shall contain eight (8) different colors from a palette of sixty-four (64).

7. Graphics software shall be provided to display on single or multiple screens, the status of every device located on a floor plan of the building. Alarms shall be audio and visual and shall annunciate regardless of the screen that is currently visible. Text on screens shall be a minimum of 1/10" high. Coordinate with the Owner, the floor plan on each screen prior to programming.
 8. Provide TROUBLE ACKNOWLEDGE, DRILL, and ALARM SILENCE capability at the color graphics annunciation location.
 9. The systems shall operate on the most current UL 864 listed computer system. The system shall be supplied by the fire alarm vendor and be listed for fire alarm use.
 10. Provide an uninterruptible power supply (UPS) to provide a minimum of 10 minutes of operating power for the computer graphic annunciator upon loss of normal power.
 11. All equipment for the color graphics network annunciator shall be suitable for locating on a desk, provided by the Owner. When multiple workstations are required (multiple locations within a facility or multiple buildings on a campus), they shall be server/client based configuration.
 12. Remote Client Workstations: All workstations shall have the same user functionality. User shall have the ability to take over network control functionality from any station as follows:
 - a. Request to take control
 - b. Accept/deny control request
 - c. Restore command center to normal operation
 - d. Priority request override
 13. PC computer workstation shall have the following minimum operating system requirements:
 - a. Operating system shall be a minimum of Microsoft Windows 7.
 - b. 3.0 GHz processor (server workstation)
 - c. 128 GB RAM installed (server workstation)
 - d. i7 Intel processor (client workstation)
 - e. 32 GB RAM installed (client workstation)
 - f. 500 GB hard drive
 - g. 22-inch LCD monitor minimum
- B. Printer:
1. Printer shall be UL 864 listed and shall be the automatic type with code, time, date, location, category and condition.
 2. The printer shall provide hard copy printout of all changes in status of the system and shall time-stamp such printouts with the current time of day and date. The printer shall be standard carriage with 80 characters per line and shall use standard bond paper. The printer shall be enclosed in a separate enclosure, suitable for placement on desk or countertop. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association Standard EIA-232D. Power to the printer shall be 120 VAC, 60 Hertz.

3. The printer shall be connected to the graphics annunciator PC and shall have all interfaces in place to be connected to the Fire Command Center and all transponders in case of network or hardware failure.

C. Remote LCD Annunciators:

1. Auxiliary annunciators shall indicate alarm and trouble conditions visually and audibly as shown on the drawings. Provide local TROUBLE ACKNOWLEDGE, TEST, and ALARM SILENCE capability. Minimum 80-character display.
2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
3. A single key switch shall enable all switches on the annunciator.
4. Mounting: Flush.

D. Facility Management Control System (FMCS) Interface:

1. Provide addressable relays to report the following to the FMCS via dry contact monitoring on the FMCS:
 - a. General Alarm
 - b. System Trouble
 - c. Supervisory Alarm
 - d. Other Alarms (if applicable)

OR
2. Provide BACnet IP interface for fire alarm panel to communicate status with the FMCS. Provide list of points and descriptions to FMCS supplier.
 - a. UL listed to Standard 864. Provide RJ45 connection and cable.

E. Fire Alarm Remote Indicator:

1. Red LED type.
2. Mounts flush to a single gang box.

F. Fire Alarm Remote Indicator and Test Switch:

1. Red LED type.
2. Key switch test selector.
3. Mounts flush to a single gang box.

2.02 ETHERNET NETWORK

- A. Campus Ethernet IP Network: A complete fire alarm and mass notification Ethernet network shall be provided. The network shall be Class X wiring, Resilient Ethernet Protocol (REP) 100BaseTX / 100 Mbps that shall be able to operate with any single break and restore network communications.

- B. The IP network shall be fiber optic cable, single or multi-mode fiber. The TCP/IP network switches shall be industrial grade managed switching hubs. Network switches shall be UL864 listed, shall provide a minimum of four (4) or a maximum of eight (8) 10/100 Mbps shielded RJ-45 connectors for Ethernet connections, and selectable multi-mode or single-mode fiber ports. The switches shall operate on a nominal 24 VDC supplied from a battery backed up fire alarm control panel or booster power supply to ensure power to the switch is always available. Switches shall provide LED indicators for data rate, activity/link integrity, power, and loop detection.
- C. IP Monitor and Relay Module: The IP relay/input module shall have a minimum of four (4) dry contact inputs and four (4) dry contact outputs. The relay output shall be rated at
- D. 0.5 amps at 24 VDC. This unit shall be monitored and controlled by the graphics workstation to operate functions and/or operations/activations on any fire alarm network system connected to the GEGW. The module shall be UL2572 and UL864 listed.
- E. Voice Over IP Module Encoder/Decoder: Each control panel audio source connected to the LAN/WAN network interface shall consist of a supervised audio decoder capable of decoding MP3, WMA, G.700, and PCM data streams in HTTP, UDP, or RTP format. Audio decoder shall operate on filtered-regulated 24 VDC power derived from the panel power supply. Power shall be supplied directly from the FACP to ensure reliable and monitored power. UL 2572 and UL864 listed.

2.03 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

- A. Smoke Damper:
 - 1. Motorized type, 120 VAC, furnished and installed by MC. Fire alarm control and power connections by EC. A subscript is used to identify the device with a specific air handler or zone for its sequence of operation.
- B. Smoke or Fire/Smoke Damper Controller:
 - 1. Provide an enclosure and equipment for interface of dampers with the fire alarm system and temperature control system
- C. Hoistway Damper (Elevator Shaft Damper):
 - 1. Motorized type, 120 VAC, furnished and installed by MC. Fire alarm control and power connections by EC. A subscript is used to identify a hoistway damper with a specific elevator or bank of elevators.
- D. Duct Smoke Detector and Smoke Damper Control:
 - 1. Sampling type duct detector in ducts 18" and larger. In-duct smoke detector in ducts less than 18". Detector shall be mounted within 5' of smoke damper. Motorized type 120 VAC, smoke damper furnished and installed by MC. Fire alarm control and power connections by EC. Remote indicator mounted in visible location. Provide auxiliary relay base or addressable control module. The smoke damper shall close upon activation of the detector, and a supervisory signal shall be sent to the fire alarm control panel.
- E. Flow Switch:
 - 1. Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.

F. Monitor Switch:

1. Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.

G. Post Indicator Valve:

1. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.

H. Electronic Bell:

1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.

I. Door Hold Open Device:

1. Integral with door hardware, 120 VAC. Furnished and installed by GC. Fire alarm control and power connections by EC.

J. Hold Open Override:

1. Hold open override connection to GC-provided power door operator. EC shall intercept the hold open switch wiring (unless specific contacts for this purpose are provided on the door) and connect addressable relay to override this switch and allow the door to close. All modifications to the power door operator shall be coordinated with the GC.

K. A/V Amplification System Shutdown

1. Connection to A/V Amplification power supply to result in AV System shutdown upon fire alarm system activation.

2.02 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.

B. All network wiring shall be fiber and installed in conduit.

END OF SECTION

DIVISION 31

EARTHWORK

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SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
 2. Removing existing trees, shrubs, groundcovers, plants, and grass.
 3. Clearing and grubbing.
 4. Stripping and stockpiling topsoil.
 5. Removing above- and below-grade site improvements.
 6. Disconnecting, capping or sealing, and removing site utilities, and abandoning site utilities in place.
 7. Temporary erosion and sedimentation control measures.

1.02 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.03 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site-clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.04 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed or abandoned per plan.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

3.05 CLEARING AND GRUBBING

- A. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of eight inches and compact each layer to a density equal to adjacent original ground, unless noted otherwise per project Geotechnical Report or project specific Specification Section.

3.06 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.07 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.08 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

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SECTION 31 22 00

GRADING

PART 1 GENERAL

1.01 SUMMARY

A. This Section Includes:

1. General exterior grading, cutting and filling, including grading for building area, paving, planting areas, banks and hillsides.

1.02 PROJECT REQUIREMENTS

A. General:

1. Before grading, contact Underground Service Alert of Southern California (USASC) for information on public buried utilities and pipelines. Retain the services of an underground utility locator for on-site utilities.

1.03 QUALITY ASSURANCE

- A. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.04 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Type "B" Material: Backfill placed beside pipe in a trench, including haunches to support sides of pipe.
2. Initial Backfill: Backfill placed over pipe in a trench.
3. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subgrade and hot-mix asphalt or concrete paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Classified Excavation: Removal and disposal of materials not defined as rock

F. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.
- K. Unclassified Excavation: Removal and disposal of materials encountered regardless of nature of materials, including rock.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.05 PROTECTION

- A. Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.
- B. Existing Facilities: Protect and maintain in satisfactory manner, existing pavements, curbs, gutters, structures, conduits, fences, walls and other facilities to remain above and below grade. Restore facilities damaged by construction operations.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Sand, gravel, friable earth, or non-expansive clays, subject to Testing Laboratory's approval. Fill and backfill material shall be free of organic material, slag, cinders, expansive soils, trash or rubble and stones having maximum dimension greater than six inches.
- C. Unsatisfactory Soils: Expansive and other soils as defined in the project's geotechnical investigation report.
1. Unsatisfactory soils also include satisfactory soils not maintained within two percent of optimum moisture content at time of compaction.

- D. Base Course: Material conforming to SSPWC section 200-2.2, Crushed Aggregate Base or SSPWC section 200-2.4 Crushed Miscellaneous Base.
- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a one and one-half-inch sieve and not more than 12 percent passing a No. 200 sieve.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing" or "Demolition."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing" or "Demolition," during earthwork operations. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.
- D. Install grade stakes and compare to indicated grades. If discrepancies are found between existing grades and grades indicated on Drawings, do not proceed until discrepancies are resolved.

3.02 ROUGH, (REMEDIAL) AND FINE GRADING

- A. Rough grade area sufficiently high to require cutting by fine grading:
 - 1. Grade area for bituminous surfacing and other paving to the indicated grades, equal to the section of the indicated base and pavement.
 - 2. Slope banks to required finish grades as cut progresses or leave cuts full and finish grade by mechanical equipment to provide grades and soil densities indicated on the Drawings.
 - 3. Rough grade, fill and compact banks beyond indicated finish grades. Finish grade banks and slopes to indicated grades and specified soil densities.
 - 4. Grade Only Areas: In areas not indicated to receive pavement, rough grade to approximate finish grades and then scarify, moisten and roll to obtain required density and indicated finish grades.
 - 5. Tolerances: Finish grades shall be within a tolerance of 0.05 inch per foot above or below grades indicated. Provide an average grade as indicated.
- B. Soils import requirement
 - 1. The contractor must provide test report, at his own cost, to indicate the soils is clean based on the requirements in EPA standards and subset DTSC "Clean Imported Fill Material", October 2001.
 - 2. The contractor shall ensure that the import soil submittal complies with Greenbook standards.

3. The contractor shall obtain paperwork from the LOR or a District Environmental agency confirming that the import fill material is characterized, handled, and documented in accordance with EPA and State of California regulations.

C. Base:

1. After subgrade has been constructed to approximate required grades, scarify to a depth of at least 6 inches:
 - a. After scarifying, process loosened material to a finely divided condition and adjust moisture content to optimum condition by addition of water, addition and blending of dry suitable material, or by drying of existing material.
 - b. Install base course in accordance with Specifications.
2. Tolerance of completed grades of base or subgrade shall not vary more than 0.03 inch per foot from grades indicated. Provide an average grade as indicated.

3.03 EXCAVATION

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.04 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus one inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 SHORING

- A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.
- B. Design and Calculations: Provide in accordance with requirement of Cal OHSA.
- C. Remove shoring upon completion of the Work of this section or when no longer needed unless required otherwise by authorities having jurisdiction.

3.06 EXCESS MATERIAL DISPOSAL

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.07 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 31 23 16

EXCAVATION AND FILL FOR PAVING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
 - 2. Drainage course for slabs-on-grade.
 - 3. Base course for concrete walks pavements.
 - 4. Base course for asphalt paving.

1.02 PROJECT REQUIREMENTS

- A. Import and Export of Earth Materials:
 - 1. Fees: Pay as required by authorities having jurisdiction over the area.
 - 2. Bonds: Post as required by authorities having jurisdiction over the area.
 - 3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

1.03 SUBMITTALS

- A. Imported Soils: A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this section.

1.04 QUALITY ASSURANCE

- A. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.05 PROTECTION

- A. Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.
- B. Existing Facilities: Protect and maintain in satisfactory manner, existing pavements, curbs, gutters, structures, conduits, fences, walls and other facilities to remain above and below grade. Restore facilities damaged by construction operations.

- C. Pumping and Draining: Excavate areas in such manner as to afford adequate drainage. Control grading in vicinity of excavated areas so ground surface will slope to prevent water running into excavated areas. Until work is completed, remove water from areas of construction that may interfere with proper performance of work or that may result in damage to the soil subgrade and provide sumps, pumps, well points, electric power and attendance required for this purpose on a 24-hour basis if necessary. Protect construction from water during construction, including prevention of erosion of completed work during construction and until permanent drainage and erosion controls are operational. Repair adjoining properties, facilities and streets damaged due to improper protection.

PART 2 PRODUCTS

2.01 BASE MATERIALS

- A. Concrete Slabs on Grade: Provide "Crushed Aggregate Base "as specified in the Standard Specifications for Public Works Construction, Section 200: "Rock Materials," with $\frac{3}{4}$ inch maximum size aggregates. Provide 4"-inch thick base, unless noted otherwise.
- B. Bituminous Surfacing: As indicated on Drawings.

2.02 FILL AND BACKFILL MATERIALS

- A. Fill and backfill materials shall be previously excavated materials or imported fill material, free of clods and stones larger than 3-inch, foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.
- B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended or aerated to stabilize and upgrade the material.
- C. Imported Fill Material:
1. Provide suitable materials obtained from Project site excavations for earthwork and fill materials. If excavated materials are not of suitable quality or sufficient quantity, import additional materials as necessary.
 2. Imported fill shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing 200 mesh sieves. Material shall have a coefficient of expansion of not more than 2 percent from air dry to optimum moisture content and not more than 6 percent from air dry to saturation. Imported material shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.
- D. Other Fill Materials: Brick rubble and broken concrete originating from the Project site may be legally disposed of off the Project site or incorporated in fill, if reviewed by a geotechnical engineer, retained by the Owner as an Owner Consultant. Unless otherwise required, no such materials may be imported from outside the Project site.
- E. Permeable Backfill:
1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

Sieve Size:	Percentage Passing:
3/4 inch (19mm)	100

3/8 inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3

2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.
3. Provided backing for weep holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.
4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system, Miradrain by Mirafi, Inc., or equal, may be provided if reviewed by the Architect.

PART 3 EXECUTION

3.01 SITE PREPARATION

- A. Clear the Project site as required in Section 31 1000 - Site Clearing.

3.02 PROTECTION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing" or "Demolition," during earthwork operations. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.

3.03 EXISTING UTILITY LINES

- A. Protect existing utility lines from damage or displacement.
- B. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of 2 feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

3.04 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.05 FILL

- A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.
- B. Provide fill materials as specified in Part 2 - Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- C. Soils import requirement

1. The contractor must provide test report, at his own cost, to indicate the soils is clean based on the requirements in EPA standards and subset DTSC "Clean Imported Fill Material", October 2001.
 2. The contractor shall ensure that the import soil submittal complies with Greenbook standards.
 3. The contractor shall obtain paperwork from the LOR or a District Environmental agency confirming that the import fill material is characterized, handled, and documented in accordance with EPA and State of California regulations.
- D. Imported fill materials shall be sampled by a geotechnical engineer, retained by the Owner as an Owner Consultant, for compliance with the requirements of Part 2 of this Section.
- E. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall submit samples to a DSA approved independent approved testing laboratory for testing.
- F. Initial sampling shall be performed by the geotechnical engineer, retained by the Owner as an Owner Consultant, before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain both the initial and additional samples from the identified site and shall submit samples to the approved independent testing laboratory for testing.
- G. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing tested for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- H. The independent approved testing laboratory shall perform the required tests and report results of tests noting if the tested material passed or failed such tests and shall furnish copies to the Project Inspector, Architect, OAR, DSA, Contractor, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC, and the DSA. Upon completion of the Work of this section, the independent testing laboratory and geotechnical engineer shall submit a verified report to the DSA as required by CBC.
- I. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.
- J. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

3.06 INSTALLATION OF MATERIALS

- A. Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the geotechnical engineer, retained by the Owner as an Owner Consultant, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but no more than 1 in 20. Provide adequate drainage at all times during construction of the Work of this section.

3.07 COMPACTING

- A. Each layer of fill material shall be compacted by tamping, sheepsfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.
- B. Unless otherwise indicated, compact each layer of earth fill to a relative compaction of at least ninety percent where placed in non-structural areas, landscaping areas and utility trenches. Jetting or flooding of backfill should not be permitted. The upper 24" of subgrade supporting pavements should be compacted to at least ninety five percent relative compaction.
- C. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each compacted layer before installing the next succeeding layer.

3.08 INSPECTION AND TESTING

- A. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavations, sample material quality as required in Part 2, and observe installation and compaction of fill materials.
- B. The geotechnical engineer, retained by the Owner as an Owner Consultant, will sample imported fill materials from their designated source before delivery to the Project site.
- C. Installation of backfill shall be observed by the geotechnical engineer, retained by the Owner as an Owner Consultant.
- D. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavation Work before the installation of fill and/or other materials.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

3.09 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
- D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.10 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

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SECTION 31 23 23

EXCAVATION AND FILL FOR UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating, backfilling, and compacting utility trenches such as water, gas, irrigation, storm drain, sewer lines, concrete-encased conduits, and manholes, vaults, valve boxes, catch basins, underground tanks, thrust blocks, yard boxes, pull boxes and other utility appurtenances.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.
3. Examine site, Drawings, records of existing utilities and construction, record of test borings, and subsurface exploration report available from Owner. Records of test borings are for information only and are not guaranteed to represent all conditions that will be encountered.

1.03 SUBMITTALS

- A. Imported Soil: A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this section.

1.04 QUALITY ASSURANCE

- A. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.05 PROTECTION

- A. Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.
- B. Existing Utilities:

1. Maintain existing utilities that are to remain in service. Before excavating over or adjacent to existing utilities, notify utility Owner to ensure protective work will be coordinated and performed in accordance with utility Owner's requirements. If existing service lines, utilities and utility structures, which are to remain in service, are uncovered or encountered during these operations, safeguard and protect from damage.
2. Within limits of excavation, remove existing piping, subsoil drainage systems, conduit, manholes and relocated items, which are to be abandoned. Plug open ends of utilities to remain with concrete.
3. Re-route existing subsoil drains which obstruct work around new constructions or incorporate them into new drainage systems.
4. Consult Architect immediately for directions, should uncharted or incorrectly charted piping or other utilities be encountered during excavation. Cooperate with Owner and public and private utility companies in keeping their respective services, utilities and facilities in operation. If damaged, repair utilities to satisfaction of Architect and utility Owner.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bedding material from trench bottom to one foot above the pipe:
 1. Sand, gravel, crushed aggregate or native free-draining granular material providing a sand equivalent of at least 30 or a coefficient of permeability greater than 1.4 inches per hour.
 2. Sand complying with the Specifications for cement concrete aggregates.
- B. Backfill Materials:
 1. Excavated trench material to be installed for backfilling shall be clean, free of large clods, and stones larger than 2 ½-inch in any dimension.
 2. Cement-sand slurry shall be provided with one sack of cement per cubic yard of the mixture.
 3. Imported Fill Material: Imported fill material shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing a 200 mesh sieve. Material shall provide a coefficient of expansion of not more than two percent from air dry to optimum moisture content and not more than six percent from air dry to saturation. Imported materials shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

2.02 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, six inches wide and four mils thick, continuously inscribed with a description of the utility. Refer to Section 22 00 00 Plumbing System Design Criteria, Section 1.1.L for tracer wire specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. Before excavation, contact the "Underground Service Alert of Southern California" (USASC) for information on buried public utilities and pipelines. For on-site utilities retain an underground locating service.
- B. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 50 00 - Construction Facilities and Temporary Controls, and in accordance with Cal-OSHA standards and requirements.
- C. Saw-cut concrete or bituminous paving for trench installation.
- D. Trenches over 5 feet in depth shall conform to the Cal-OSHA.
- E. Where indicated and required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.
- F. Backfill over excavations to the required elevations with earth, gravel, sand, or concrete and compact as required. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. Slope adjacent grades away from excavations to minimize entry of water.
- G. Do not install piping lengthwise under concrete walks without review by the Architect.
- H. Do not excavate trenches parallel to footings closer than 18 inches from the face of the footing or below a plane having a downward slope of two horizontal to one vertical, from a line 9 inches above bottom of footings.
1. Unless otherwise indicated on Drawings, depth of excavations outside the buildings shall allow for a minimum coverage above top of pipe, tank, or conduit measured from the lowest adjoining finished grade, as follows:

Steel Pipe	24	inches	below
finished grade Copper Water Tube	18	inches	below
finished grade Cast-Iron Pressure Pipe	36	inches	below
finished grade Plastic Pipe (other than waste)	30	inches	
below finished grade Tanks or other structures	36	inches	
below finished grade			
Soil, Sewer & Storm Drain	minimum 18 inches below finished grade, and as required for proper pitch and traffic load. (Install polypropylene sewer pipe with at least 24 inches coverage)		
Irrigation Pipe:	nonpressure pipe 12 inches, pressure pipe 24 inches		
 2. Trench width shall provide ample space for fitting and joining. Excavate for piping bells and fittings, bell and spigot pipe and other fittings.
 - I. Unless indicated otherwise, excavate trenches to the required depths for utilities, such as pipes, conduit and tanks, with minimum allowances of 6 inches at the bottom and 6 inches at the sides for bedding of unprotected piping or as required for concrete encasement of conduits as indicated on Drawings. Grade bottom of trenches to a uniform smooth surface. Remove loose soil from the excavation before installing sand bedding or concrete encasement.

- J. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed soil and fill as required. Slope adjacent grades away from excavations to minimize entry of water.
- K. Provide a minimum clear dimension of 2 inches from sides of wall excavation to outer surfaces of buried pipes or conduits installed in the same trench or outside surfaces of containers and tanks.
- L. Do not install backfill until required inspections and testing is completed.
- M. Backfill electrical or other excavated utility trenches located outside of barricaded installation areas within 24 hours after inspection by the Project Inspector.
- N. Install backfill materials in layers not exceeding 4 inches in thickness and compact to 90 percent of the maximum density. Jetting or flooding of backfill should not be permitted.
- O. If materials excavated from the Project site are not permitted for trench backfill in paved areas, backfill trenches with a cement-sand slurry mix. Install backfill to an elevation of the existing undisturbed grade plus one inch.
- P. Install and compact sand bedding to provide a uniform full length bearing under piping and conduits.
- Q. Where portions of existing structures, walks, paving, or other improvements are removed or cut for piping or conduit installation, replace the material with equal quality, finished to match adjoining existing improvements. Repair pavement as specified in Section 32 0117 - Pavement Repair.

3.02 IMPORT/EXPORT OF MATERIALS

- A. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- B. Soils import requirement
 1. The contractor must provide test report, at his own cost, to indicate the soils are clean based on the requirements in EPA standards and subset DTSC "Clean Imported Fill Material", October 2001.
 2. The contractor shall ensure that the import soil submittal complies with Greenbook standards.
 3. The contractor shall obtain paperwork from the LOR or a District Environmental agency confirming that the import fill material is characterized, handled, and documented in accordance with EPA and State of California regulations.
- C. Imported fill materials shall be sampled by a geotechnical engineer, retained by the Owner as an Owner Consultant, for compliance with the requirements of Part 2 of this section.
- D. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform the tests by utilizing an independent approved testing laboratory.

- E. Initial sampling shall be performed by the geotechnical engineer, retained by the Owner as an Owner Consultant, before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain both the initial sample and additional samples from the identified site and shall submit all samples to the approved independent testing laboratory.
- F. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- G. The independent approved testing laboratory shall perform the required tests and report results of all tests noting if the tested material passed or failed such tests and shall furnish copies to the Project Inspector (IOR), Architect, OAR, DSA, Contractor, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC and the DSA. Upon completion of the Work of this section, the independent testing laboratory and geotechnical engineer shall submit a verified report to the DSA as required by CBC.
- H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.
- I. Upon completion of import operations, provide the IOR a certification statement attesting that imported material has been obtained from the identified source site.

3.03 INSPECTION AND TESTING

- A. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavations, sample material quality as required in Part 2, observe installation and compaction of fill materials.
- B. Compaction test shall be performed in accordance with ASTM D1557, method "C."

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

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DIVISION 32
EXTERIOR IMPROVEMENTS

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SECTION 32 01 30

OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Work Specified in this Section: Furnish all labor, material, equipment, and services required to maintain the landscape in an attractive condition as specified herein for a period of 90 calendar days.
- B. Related Work Specified in Other Sections:
 - 1. Section 32 84 00: Planting Irrigation
 - 2. Section 32 84 13: Drip Irrigation
 - 3. Section 32 90 00: Planting
 - 4. Section 32 92 19: Seeding
- C. Definition: The word Architect as used herein shall refer to the Landscape Architect or the Owner's authorized representative.

1.02 QUALITY ASSURANCE

- A. The Contractor's representatives and employees shall be experienced in landscape maintenance.

1.03 90 CALENDAR DAY MAINTENANCE PERIOD

- A. The Contractor shall continuously maintain all areas involved in this Contract during the progress of work. Maintenance period shall not start until all elements of construction, planting, and irrigation for the entire project are in accordance with Plans and specifications.
 - 1. A prime requirement is that all lawn and groundcover areas shall have been planted and that all lawn areas shall show an even, healthy stand of grass seedlings or sod, either of which shall have been mowed twice. The Maintenance Period will not be shortened when this criterion is met, but may be lengthened if not met.
 - 2. The Contractor's Maintenance Period will be extended if the provisions required within the Plans and specifications are not fulfilled. Project may not be segmented into maintenance phases.
 - 3. The Contractor shall request a Pre-Maintenance inspection by the Owner and Architect at the completion of the installation process.
 - 4. The Maintenance Period shall begin upon successful completion of the Pre-Maintenance walk-through punch list and acceptance of the landscape installation by the Owner.
 - 5. If such criteria are met to the satisfaction of the Owner, a field notification will be issued to the Contractor to establish the effective beginning date of the Maintenance Period.
- B. The Maintenance Period continues for 90 calendar days until final acceptance of the work by the Owner. Improper maintenance or poor condition of planting at the termination of the scheduled Maintenance Period may cause postponement of the final completion date of the Contract.

- C. Any day when the Contractor fails to adequately maintain planting, replace unsuitable plants or do weed control or other work, as determined necessary by the Owner, will not be credited as one of the Maintenance Period working days.

1.04 GUARANTEE AND REPLACEMENT

- A. Guarantee: All plant material installed under the contract shall be guaranteed for a period of one year from the start of the Maintenance Period. Plants found to be dead or in poor condition due to faulty materials or workmanship, as determined solely by the Architect, shall be replaced by the Contractor at his expense.
 - 1. Replacement: Materials found to be dead, missing, or in poor condition during the Maintenance period shall be replaced immediately.
 - 2. The Architect shall be the sole judge as to the condition of material.
 - 3. The Contractor shall replace material rejected during the Guarantee period within fifteen (15) days of written notification by the Owner.

1.05 OBSERVATION VISITS

- A. The Contractor shall request progress visits from the Architect at least 72 hours in advance of anticipated visits. Normal observation visits are as follows:
 - 1. Immediately prior to the commencement of the work in this section.
 - 2. Completion of first 90 days of maintenance.
 - 3. Final acceptance.

1.06 FINAL ACCEPTANCE OF THE PROJECT

- A. Prior to the date of the final observation visit, the Contractor shall acquire from the Architect-approved reproducible Plans and record (from the job record set) all changes made during construction, label these Plans "Record Drawings", and deliver to the Architect for review and approval.
- B. Prior to the date of final inspection, the Contractor shall deliver to the Architect a written "Landscape and Irrigation Guarantee" as required herein.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials used shall either conform to landscape specifications in other sections or shall otherwise be acceptable to the Owner.
- B. The Owner shall be given a monthly record of all herbicides, insecticides, and disease control chemicals used. Failure to provide such a record will continue Maintenance Period until compliance occurs.

PART 3 EXECUTION

3.01 MAINTENANCE

- A. Maintenance shall be performed according to the following standards:

1. All areas shall be weeded and cultivated at intervals of not more than ten (10) days.
2. Watering, mowing, rolling, edging, trimming, fertilization, spraying, and pest and rodent control, as may be required, shall be included in the Maintenance Period.
3. Street gutters shall be cleaned as part of the maintenance program.
4. The Contractor shall be responsible for maintaining adequate protection of the area.
 - a. Damaged areas shall be repaired at the Contractor's expense.
5. Between the 15th day and the 20th day of the Maintenance Period, the Contractor shall reseed and re-sod all spots or areas within the lawn where normal turf growth is not evident.

- B. The Contractor shall be responsible for reporting to the Owner conditions beyond his control that prevent or have a negative impact on the work required herein.

3.02 TREE AND SHRUB CARE

A. Watering

1. Apply enough irrigation water so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
 - a. Do not maintain soil in a constantly wet condition.
 - b. Contractor shall be responsible for familiarizing himself with the water requirements for the various plantings and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
 - c. Damage to the plantings caused by over-watering or under-watering shall be the responsibility of the Contractor to replace at no cost to Owner.
2. Maintain a water basin around newly planted plants so that water can be applied to moisturize throughout the root zone. At the end of the Maintenance Period these basins shall be flattened out to match surrounding grades.
3. If hand-watering, use a fan spray nozzle to break the water force.

B. Tree Pruning

1. Nursery grown trees will not normally require pruning for the first year. Prune trees only if directed by Architect or Owner, and only for these purposes:
 - a. selection and development of permanent scaffold branches that have a vertical spacing of from 18" to 48" and radial orientation so as not to cross each other,
 - b. elimination of diseased or damaged growth,
 - c. elimination of narrow V-shaped branch forks that lack strength,
 - d. reduction of toppling and wind damage by thinning out crowns,
 - e. maintenance of growth within space limitations,
 - f. maintenance of natural appearance,
 - g. Balancing of crown-to-root ratio.
2. Under no circumstances will stripping of lower branches ("rising up") of young trees be permitted.
 - a. Lower branches shall be retained in a "tipped-back" or pinched condition with as much foliage as possible to promote caliper trunk growth (tapered trunk).

- b. Lower branches can be cut flush with trunk only after the tree is able to stand erect without staking or other support.
 3. Evergreen trees shall be thinned out and shaped when necessary to prevent wind and storm damage. The primary pruning of deciduous trees shall be done during the dormant season. Damaged trees or those that constitute health or safety hazards shall be pruned at any time of the year as required.
- C. Shrub Pruning
1. The objectives of shrub pruning are the same as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the design.
 2. All pruning cuts shall be made to lateral branches or buds or flush with the trunk. "Stubbing" will not be permitted.
- D. Staking and Guying: Stakes and guys shall remain in place until final acceptance and are to be continuously inspected and adjusted to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds and to allow trees to sway freely. Stakes and guys are to be removed when trees become sufficiently well rooted or after one year. When stakes or guys are removed, tree heads may be thinned to reduce wind load.
- E. Weed Control: Keep all areas, including basins and areas between plants, free of weeds.
1. Use recommended legally approved herbicides only when mechanical removal methods are not feasible.
 2. Avoid frequent soil cultivation next to trees or shrubs that destroys shallow roots.
 3. Use mulches to help prevent weed seed germination.
- F. Pest and Disease Control: Maintain control of insect and rodent infestations. The preferred method of control shall be biological control, or with non-toxic, biodegradable, organic materials. If stronger materials are needed, only materials that are recommended by a licensed Pest Control Advisor and are EPA approved and regulated shall be used. Only registered and licensed Pest Control Operators shall apply insecticide or chemical applications. Notify Owner a minimum of five (5) working days before chemical applications.
- G. Fertilization
1. Fertilize all planting areas at 30-day intervals, with fertilizer and at rate as recommended by Soils Report.
 - a. Avoid applying fertilizer to root balls and bases of main stems.
 - b. Spread fertilizer evenly around plants to drip line.
 - c. Distribute fertilizer evenly over turf or groundcover areas to avoid patchy coloration.
- H. Replacement of Plants: Replace dead, dying, and missing plants with plants of a size, condition, and variety acceptable to Architect or Owner at Contractor's expense.
- 3.03 GROUND COVER CARE
- A. Weed Control: Control weeds preferably with mechanical methods, and also with preemergent herbicides and selective systemic herbicides. Hoe weeds as little as possible since this may result in plant damage. Foot traffic in planted areas shall be minimized, and soil compaction shall be loosened immediately.

- B. Watering: Water enough so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
 - 1. Do not maintain soil in a constantly wet condition.
 - 2. The contractor shall familiarize himself with the particular water requirements for the planting and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
 - 3. Damage to the planting caused by over-watering or under-watering shall be the responsibility of the Contractor to replace.
- C. Trash: Remove trash weekly. Remove debris, clippings or branches produced by maintenance activities within 8 hours.
- D. Edging and Trimming: Edge ground cover to keep in bounds and trim top growth as necessary to achieve an overall even appearance.
- E. Replacement: Replace dead and missing plants at Contractor's expense.

3.04 LAWN AND TURF CARE

- A. Mowing and Edging:
 - 1. Mowing of turf will commence when the grass has reached a recommended height for the specified species. Mowing will be at least twice a week after the first cut. Turf must be well-established and free of bare spots and weeds to the satisfaction of the Architect prior to final acceptance.
 - 2. Edges shall be trimmed at least weekly or as needed for a neat appearance.
 - 3. Grass clippings, if visible in piles regardless of size shall be removed from the premises.
- B. Watering: Lawns shall be watered at such frequency as weather conditions require to replenish soil moisture below root zone and maintain healthy growth.
- C. Fertilizing:
 - 1. Fertilize all on-grade lawn areas as follows or as recommended by soils report:
 - a. At the end of the first 30 calendar days and at 30 to 90 calendar day intervals thereafter - 5 lbs. per 1,000 square feet of maintenance fertilizer.
 - b. After application, irrigate thoroughly.
- D. Weed Control: Remove broad leaf weeds manually or control with selective herbicides. Turf areas shall be kept weed-free.
- E. Renovating:
 - 1. If required, remove thatch by verticutting, preferably in the fall but otherwise in the spring. At this time, fertilize with maintenance fertilizer and over-seed if needed.
 - 2. Aerify compacted areas to improve water penetration whenever needed.

3.05 IRRIGATION SYSTEM

- A. System Inspection: Contractor shall continuously check all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each of the lateral. All heads are to be continuously adjusted as necessary for proper coverage and to eliminate over-spray on buildings or paving. Contractors' regular maintenance personnel shall test, observe, and adjust each sprinkler system no less than once per month.
- B. Controllers: Set and program automatic controllers for seasonal water requirements and minimum optimum water use. Give Owner's representative a key to controllers and instructions on how to turn off system in case of emergency.
- C. Repairs: Repair all damage to irrigation system at Contractor's expense. Repairs shall be made within one watering period.

END OF SECTION

SECTION 32 01 90.33

TREE AND SHRUB PRESERVATION

PART 1 GENERAL

1.01 SUMMARY:

- A. Provide all labor, materials, equipment, services, and miscellaneous and incidental work to provide all tree protection as indicated on the Drawings and as specified including:
 - 1. Protection and welfare of all existing trees that are to remain, including trimming, cabling, and repair of such trees as necessary.
 - 2. Contractor shall submit tree maintenance plans including temporary irrigation system for Owner's Representative's approval.
 - 3. Completely coordinate all Work.

1.02 DEFINITIONS:

- A. "Injury" is defined, without limitation, as any bruising, scarring, tearing, or breaking of roots, branches or trunk.
- B. "Drip line" is defined as the outermost limits of the tree canopy.
- C. ISA: International Society of Arboriculture.
- D. Certified Arborist: an ISA-certified arborist.

1.03 QUALITY ASSURANCE:

- A. General Responsibility: The Contractor shall be directly responsible for protection and welfare of existing trees within the Contract Limits, which are noted to remain. This responsibility shall continue throughout the full construction period until the entire Project is completed and accepted by Owner and through completion of the guarantee period.
- B. Qualifications of Workmen: only a certified arborist or certified tree worker shall perform Trimming. Provide at least one person approved by Owner who shall be present at all times during tree protection and trimming operations, who shall be thoroughly familiar with the type of work involved, and who shall direct all protection and trimming work.
 - 1. All tree trimming on this project shall be under the direction of Owner's Representative.
 - 2. Pruning of mature trees shall be considered as part of this project at the discretion of the Landscape Architect and/or Owner's Representative.
- C. Reference Standards: Published specifications, standards, tests, or recommended methods of trade, industry or governmental organization apply to work of the Section.
 - 1. International Society of Arboriculture (ISA) "Guide for Establishing Values of Tree and Other Plants," prepared by the Council of Tree and Landscape Appraisers (CTLA).
 - 2. "Cabling, Bracing and Guying Standards for Shade Trees," as published by the National Arborist Association (NAA), 174 RT 101, Bedford, New Hampshire, 03102.
 - 3. International Society of Arboriculture (ISA) - Tree Pruning Guidelines.

1.04 SUBMITTALS:

- A. Refer to Division 1 for procedure.
- B. Pruning.
- C. Moving Equipment.
- D. Guying materials.
- E. Fencing materials.
- F. Tree Maintenance Plan: Contractor shall submit tree maintenance plans, including design of temporary irrigation system (if required), for approval by Owner's Representative.

1.05 JOB CONDITIONS:

- A. Pre-Construction Meeting: prior to performing any work of the Contract, Contractor shall call for a site meeting with the Owner's Representatives. This meeting shall occur prior to construction of any nature on site. The purpose of the meeting shall be to establish the conditions of all existing trees to be preserved or relocated, tree protection requirements, trimming procedures, and responsibilities, upon receipt of the site by the Contractor. Failure to call for said meeting implies acceptance by the Contractor of trees to be preserved in their existing condition.
- B. Sequencing Schedule: Coordinate and cooperated with other trades to enable work to proceed as rapidly and efficiently as possible.

1.06 GUARANTEE:

- A. Contractor shall guarantee that all plants covered by the provisions of this Section will be in a healthy and flourishing condition of active growth 1 year from the date of Substantial Completion.
- B. During the warranty period the Contractor shall be liable for damages to all trees covered by the provisions of this Section and shall pay compensation to Owner.
 - 1. Contractor shall reimburse Owner for loss of trees due to damage or lack of care (See Section 1.13 - Repair Compensation).
 - 2. For trees injured, but not a complete loss to Owner, the Owner's Representative shall determine the amount of penalty.
- C. Contractor will not be held responsible for failures due to neglect by Owner, vandalism, etc., during the warranty period. Report such conditions within 24 hours to Owner's Representative.

PART 2 PRODUCTS

2.01 TREE PROTECTION FENCING:

- A. Tree Protection Fence: Eight (8') foot high chain-link fence, sturdy and capable of acting as a barrier against objects, vehicles, etc., on site during construction process. It shall be constructed and designed to allow for relocations as required and shall have gate access to inside for care of tree. It shall be continuously maintained and repaired as necessary. Metal shall be galvanized with posts set in 12" diameter x 24" depth footings with top rails.

1. Install tree protection fencing around trees to be preserved at their dripline or at a minimum of 15' from the tree's trunk. Stands of trees may be fenced as a group. Fencing shall remain until all construction work has been completed, and it shall then be removed as directed by the Owner's Representative.
2. During construction, relocation of the fence may be required to facilitate construction. The Contractor shall do so as directed by the Owner's Representative at no additional expense to the Owner and reset if necessary.

PART 3 EXECUTION

3.01 PROTECTION OF TREES:

- A. Water: Provide ample water supply of potable quality and sufficient quantity for all operations required under this section.
- B. The existing trees to be preserved presently are in excellent condition. Trees shall not be allowed to deteriorate and shall be maintained in a healthy and vigorous condition during the course of construction and maintenance period.
- C. During the course of construction, the Contractor shall take all necessary precautions, as outlined herein, to protect the existing trees to be preserved from injury or death. Protection shall be given to the roots, trunk, and foliage of all existing trees to remain.
- D. Trees subject to the provisions of this Section which have been injured, shall be repaired immediately by an approved, certified arborist. Repair may include removal of rough edges and sprung bark and severely injured branches as directed by the Owner's Representative.
- E. Tree protection fencing shall be installed for the protection of existing trees to be preserved. No construction, demolition, or work of any nature will be allowed within the fenced area without prior written approval by the Owner's Representative.
 1. Approval by the Owner's Representative for work within the fenced area shall not release the Contractor from any of the provisions specified herein for the protection of existing trees to be preserved.
 2. During construction of approved work within the fenced area, no main lateral roots, taproots, or roots larger than two (2") inches in diameter shall be cut without prior written approval by the Owner's Representative.
 3. Cut roots with sharp pruning requirements per ISA guidelines and standards.
 4. All root pruning is to be observed by a Certified Arborist.
- F. During construction the existing site surface drainage patterns shall not be altered within the area of drip line or in compliance with the development plans.
- G. Contractor shall not alter the existing water table within area of drip line during rough grading (as directed by Owner's Representative.)
- H. Take necessary measures to maintain healthy living conditions for existing trees to be preserved. Such measures shall include but not be limited to periodic washing of leaves for the removal of dust, etc.
- I. Do not permit the following within the drip line of any existing tree to be preserved:
 1. Storage or parking of automobiles or other vehicles.

2. Stockpiling of building materials or refuse of excavated materials.
3. Skinning or bruising of bark.
4. Use of trees as support posts, power poles, or signposts; anchorage for ropes, guy wires, or power lines; or other similar functions.
5. Dumping of poisonous materials on or around trees and roots. Such material includes but is not limited to paint, petroleum products, dirty water, concrete slurry, or other deleterious materials.
6. Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, and other miscellaneous excavation without prior written approval by Owner's Representative.
7. Damage to trunks, limbs, or foliage caused by maneuvering vehicles or stacking material or equipment too close to tree.
8. Compaction of the root area by movement of trucks or grading machines; storage equipment, gravel, earth fill, or construction supplies, etc.
9. Excessive water or heat from equipment, utility line construction, or burning of trash under or near shrubs or trees.
10. Damage to root system from flooding, erosion, and excessive wetting and drying resulting from dewatering and other operations.

J. Excavation Around Trees:

1. Excavation or fill within drip lines of trees shall be done only where necessary and with the direction of the Owner's Representative.
2. Where trenching for utilities is required within drip lines, it shall be under the supervision and direction of the Owner's Representative. Trenching within a tree's dripline area requires the use of hand tools. Hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.
3. Where excavation for new construction is required within drip line of trees, hand excavation may be required to minimize damage to root system. Any pruning of damaged roots or roots requiring removal shall be observed by a Certified Arborist. Roots larger than two (2) inches in diameter require written approval by the Owner's Representative prior to root pruning.
4. Exposed roots and soil areas shall not be allowed to dry out before permanent backfill is placed. Temporary earth cover or organic mulch shall be provided, or roots shall be packed with wet peat moss or four layers of wet, untreated burlap and temporarily supported and protected from damage until permanently covered with backfill. The cover over the roots shall be wetted to the point of runoff daily. When complete, install broken concrete retaining walls as shown on Plan Details wherever the grade around a tree to be saved is higher or lower by 6" from the existing grade. See Planting Plan and Details.
5. Pruning may be required to balance loss to root system caused by damage or cutting of root system. Thinning shall not exceed 30 percent of existing foliage and shall be directed by the Owner's Representative.

3.02 TREE PRUNING

- A. Pruning: Trees which require pruning shall be inspected by the Owner's Representative and the Contractor before starting work this work. All Pruning shall be in accordance with the standards of the ISA or as directed by the Owner's Representative. A sample tree shall serve as a guide in the pruning of the remaining trees.

3.03 TREE REMOVAL

- A. Trees designated for removal shall be removed to a point at least 1' (one foot) or more below subgrade. Refer to Section 02 41 00 (Demolition). Trees shall not be felled but cut down in sections and lowered to the ground to minimize damage to other trees and planting and protect against injury to anyone in the vicinity.
- B. The Owner's Representative and the Contractor's Arborist will identify limbs and roots, which are to be trimmed.
- C. The Owner's Representative shall direct the removal of branches from trees and large shrubs that are to remain if required clearing for new construction.
- D. Dead and damaged trees that are determined by the Owner's Representative and arborist to be incapable of restoration to normal growth pattern shall be removed.
- E. Cut evenly, using proper tools and skilled workmen, to achieve neat severance with the least possible damage to the tree.
- F. In the case of root cuts, apply wet burlap or other protection, approved as noted herein, to prevent drying out, and maintain them in a wet condition as long as necessary for temporary protection.

3.04 IRRIGATION SYSTEM

- A. Protect existing irrigation system from damage. Wherever possible leave water source for watering trees and keep ground around all trees to remain in the area sufficiently moist until the end of project.

3.05 REPAIR COMPENSATION

- A. Damage to existing tree crowns or roots over two (2) inches in diameter shall be immediately reported to Owner's Representative in writing, and, at the direction of the Owner's Representative, repaired immediately at the Contractor's expense by an approved, certified arborist.
- B. The Owner's Representative shall direct repair of trees damaged by construction operations. Repairs shall be made within 24 hours after damage occurs to prevent progressive deterioration of damaged trees.
- C. Any tree to remain which is damaged or destroyed owing to the Contractor's negligence or failure to provide adequate protection shall be compensated for in accordance with "The Guide for Establishing Values of Trees and Other Plants as produced by the International Society of Arboriculture.
- D. Maintenance including watering, fertilizing, pruning, pest control, irrigation, and other care to bring the replacement tree to the same general condition of original item shall be the responsibility of the Contractor.
- E. Damaged tree limbs or trees which have died because of injury during construction shall remain the property of Owner and shall remain or be removed by the Contractor as directed by Owner's Representative.

3.06 MAINTENANCE

- A. Contractor shall be responsible to perform periodic inspections of existing trees to be preserved and submit written proposals to the Owner's Representative for additional maintenance work as may be required to ensure the health and general well-being of the trees. Contractor shall retain, at the direction of the Owner's Representative additional specialists as may be required to perform this work.

- B. Irrigation: During construction the existing trees to be preserved shall, at the directions of the Owner's Representative, be irrigated to a minimum of 3' depth. Quantities and lengths of time are variable and shall depend upon climactic conditions or per the direction of the Owner's Representative.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Paving for playground, parking areas, areas between buildings, synthetic track surfacing adjacent to planting and turf areas as indicated.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 22 00 - Grading.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan indicating extent of paving and accessories.

B. Product Data: Manufacturer's technical data for materials and products.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC) and the California Department of Transportation (Caltrans), latest editions and supplements for asphalt paving work. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.04 PROJECT CONDITIONS

A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

B. A copy of the soils report is available for examination in the office of the Architect during regular office hours of the Architect.

PART 2 PRODUCTS

2.01 PAVING AGGREGATE

- A. Aggregates: Class 2 Aggregate Base in conformance with CALTRANS Section 26-1.02, MATERIALS; or Crushed Aggregate Base or Crushed Miscellaneous Base in conformance with SSPWC Section 200-2 UNTREATED BASE MATERIALS.
- B. Aggregates for Asphaltic Concrete Paving: Conform to CALTRANS Section 39-2.0B (4) Aggregates; or SSPWC Section 203-6.2.2 Rock Products for Asphalt Concrete Mixes. Plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of combined dry aggregates.

2.02 BITUMINOUS MATERIALS

- A. Tack Coat: PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications, unless noted otherwise.
- B. Provide materials of the class, grade, or type indicated on the Drawings, conforming to relevant provisions of Section 203 - Bituminous Materials of the Standard Specifications for Public Works Construction.
- C. Mixes: Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mix III-C3 PG 64-10 designed in conformance with SSPWC Section 203-6.5, unless noted otherwise.

2.03 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Wheel Stops: Precast, air-entrained concrete
 - 1. Dowels: Galvanized steel, one-half-inch diameter, 18-inch minimum length.

2.04 HEADERS

- A. Concrete: Per specification Section 32 1313 - Site Concrete Work.

PART 3 EXECUTION

3.01 HEADERS

- A. Install headers along edge of bituminous surfacing abutting turf, earth, or planting area, unless indicated otherwise.
- B. Install headers so the bottom surface has continuous bearing on solid grade. Where excavation for headers is undercut, thoroughly tamp soil under the header. Compact backfill on both sides of header to the density of adjacent undisturbed earth.
- C. Remove existing headers where new surfacing is installed adjacent to existing surfacing.
- D. Install temporary headers at transverse joints of paving where continuous paving operations are not maintained.
- E. Provide additional stakes and anchorage as required to fasten headers in place.

3.02 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of two inches.

3.03 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gallons/square yard.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.04 CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

- A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- D. Thickness of Surfacing: Unless otherwise indicated on Drawings or specified, install bituminous surfacing to a compacted thickness of 2 inches.
- E. Provide surfacing material over base course.
- F. Surfaces of walls, concrete, masonry, or existing bituminous surfacing indicated to be in direct contact with installed bituminous surfacing shall be cleaned, dried and uniformly coated with an asphaltic emulsion film.
- G. Thicken edges of bituminous surfacing that do not abut walls, concrete, or masonry, and edges joining existing bituminous surfaces. Remove headers at existing bituminous surfacing where new bituminous surfacing is to be installed. Thicken edges an additional 2 inches and taper to the indicated or specified thickness 6 inches back from such edges.
- H. At stairways, adjust thickness of paving such that the first tread is equal in height to all other treads.
- I. Provide adequate protection for concrete, planting areas, and other finish Work adjacent to areas indicated to receive bituminous surfacing.
 - 1. Placing:

2. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 3. Do not install bituminous surfacing when atmospheric temperature is below 40 degrees F; or when fog or other unsuitable weather conditions are present. Temperature of mixture at time of installation shall not be lower than 260 degrees F in warm weather or higher than 320 degrees F in cold weather.
 4. Where 2-inch or 3-inch thick surfacing is indicated or specified, install surfacing in one course. Where surfacing is indicated or specified 4 inches or more in thickness, except for thickened edges, install bituminous surfacing in courses of approximately equal thickness, each course not exceeding 2 ½ inches in thickness.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
 6. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 7. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
- J. Stakes or Screeds: Provide grade or screed stakes spaced not more than 15 feet apart in flow lines with grades of less than one percent. Continuous screeds may be provided instead of stakes.
- K. Spreading: Install bituminous surfacing in a manner to cause least possible handling of mixture. In open areas and wherever practicable, install by mechanical means with a self-propelled mechanical spreader. In confined or restricted areas, install mixture with hot shovels and rakes, and smooth with lutes.
- L. Joints: Provide vertical joints between successive runs. Install joints true to line, grade, and cross section. Lapped joints are not permitted.
- M. Rolling:
1. Finish roll with a self-propelled tandem roller weighing at least 8 tons. Break down roll with a self-propelled roller weighing between 1 ½ tons and 8 tons.
 2. Roll in a manner that preserves flow lines and the established finished grades. Break down roll in areas adjacent to flow lines parallel to flow lines. Break down roll after bituminous surfacing is installed without shoving or cracking of mixture under roller. Continue finish rolling until surfacing is unyielding, true to grade, and meets requirements for specified smoothness. Areas inaccessible to finish roller may be finish rolled with breakdown roller or tamped with hot tamping irons and smoothed with hot smoothing irons or hand roller.
 3. Where bituminous surfacing abuts concrete, masonry, walks or paving, tamp joint smooth, if necessary, as described above to obtain a uniformly even joint, true to line and grade. Tamp and smooth to properly compact.
 4. Compacted bituminous surfacing shall be provided with a bulk specific gravity of at least 2.31 when tested in accordance with ASTM D1188.
- N. Protection:

1. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
2. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.05 TOLERANCE

- A. Smoothness: Surface of bituminous surfacing after rolling, shall be even, smooth and uniform in texture with no voids or rock pockets, free of roller marks or other irregularities, and not varying by more than 0.03 foot, except at local depressions or raised areas as indicated, when a 10-foot straightedge is placed on surface.
- B. Grade: Finished grade shall not vary more than 0.02 foot above or below required grade. Variations within prescribed tolerance shall be compensating so that average grade and cross-section are provided.
- C. Premium paving tolerances and requirements for synthetic track:
 1. General: Test in-place asphalt concrete courses for compliance with requirements or thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Owner's representative.
 2. Thickness: Tolerances for thickness shall be ¼ inch, plus or minus.
 3. Planarity: The asphalt substrate shall not vary from the planned cross slope by more than plus or minus 0.1 percent. The finished asphalt shall not vary, plus or minus, under a 10 feet straight edge greater than 1/8 inch. Flood test the surface with the use of a water truck. If, after 30 minutes on a 70-degree F day, "bird baths" are evident at a depth more than 1/8 inch repair using the best method of correction.
 4. Corrective Measures: Determine if the planarity, cross slopes, and general specifications have been met. If all of the conditions have been met notify the Owner in writing of the acceptance of the asphalt paving.

3.06 TESTING

- A. After first coat of surface seal has been installed and after a 24-hour period, the flood test shall be completed of the bituminous surfacing in presence of the Project Inspector. Repair areas of standing water or puddles and flood test locally; install surface seal and retest as necessary.

3.07 SURFACE SEALING

- A. After bituminous surfacing has passed flood test, clear and allow to dry and provide one more coat of surface seal.
- B. Where indicated, provide multiple coats of surface seal to existing bituminous surfacing.
- C. Where new bituminous surfacing joins existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.09 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 12 36

EMULSIFIED SLURRY SEAL

PART 1 GENERAL

1.01 SUMMARY

- A. The work shall consist of mixing asphaltic emulsion, aggregate, set-control additives and water, and spreading the mixture on a surfacing or pavement.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Asphaltic Emulsion: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material certificates.
- D. Log of slurry seal application, including dates, times, temperature readings and other pertinent information.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Standard Specifications: Comply with latest editions and supplements for Caltrans Standard Specifications Sections 37 and 94. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: The slurry seal shall not be applied if either the pavement or air temperature is below 50 degrees Fahrenheit. and falling, but may be applied when both pavement and air temperatures are above 45 degrees Fahrenheit and rising. No slurry seal shall be applied when there is a possibility of freezing temperatures at the project location within 24 hours after application.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees Fahrenheit for oil- based materials, 50 degrees Fahrenheit for water-based materials, and not exceeding 95 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 ASPHALTIC EMULSION

- A. Asphaltic emulsion shall be a quick-setting type, grade QS1h anionic, or grade CQS1h cationic, conforming to the provisions in Caltrans Standard Specifications Section 94, Table 4. The grades of asphaltic emulsion shall be at the option of the Contractor.

2.02 AGGREGATE

- A. Aggregate shall conform to the provisions in Caltrans Standard Specification Section 37- 2.02C, Type II

2.03 WATER

- A. Water shall be such quality that the asphalt will not separate from the emulsion before the slurry seal is in place in the work. If necessary for workability, a set-control agent that will not adversely affect the slurry seal may be used.

2.04 MIX DESIGN

- A. Compatibility of the emulsified asphalt, aggregate, water and additives shall be evaluated in the mix design. The slurry seal mixture shall conform to the requirements specified when tested in accordance with the Caltrans Standard Specifications Section 37-2.03.

2.05 PAVEMENT MARKING PAINT

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with Caltrans Standard Specifications - Section 84 (Federal Specification No. TT-P-1952 for Blue, Red and Green paint; and State of California Standard Specification No. PTWB-01 for White, Yellow and Black paint) with drying time of less than 45 minutes.

- 1. Color: White

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. Prior to applying the slurry seal, loose material, oil spots, vegetation, and other objectionable material shall be removed. A standard cleaning method such as sweeping, flushing, or other means will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before slurry surfacing. Manholes, valve boxes, catch basins, and other utility boxes shall be protected from slurry seal by a suitable method.
- B. Treat cracks wider than 0.25 inches in the pavement surface with an approved crack sealer prior to application of slurry seal.

3.02 PLACING

- A. The slurring mixture shall be uniformly spread on the existing surfacing within the rate specified without spotting, re-handling or otherwise shifting of the mixture.
- B. Slurry seal shall not be placed when the atmospheric temperature is below 50 degrees Fahrenheit or during unsuitable weather.
- C. Slurry seal shall be spread at a rate specified in Caltrans Standard Specifications Section 37-2.06.
- D. The mixture shall be uniform and homogeneous after spreading on the existing surfacing and shall not show separation of the emulsion and aggregate after setting.
- E. Lumping, balling, or unmixed aggregate will not be acceptable.

- F. Adequate means shall be supplied to protect slurry seal from damage by traffic until such time that the mixture has cured sufficiently so that the slurry seal will not adhere to and be picked up by the tires of vehicles.
- G. No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or traverse joints. The contractor shall supply suitable equipment to produce a minimum number of longitudinal joints throughout the project. When possible, a longitudinal joint shall not be placed in a wheel path. Less than full box width passes will be used only as required. If less than full box width passes are used, they shall not be the last pass of any paved area. A maximum of six inches shall be allowed for overlap of longitudinal joints.
- H. Area which cannot be accessed by the mixing machine shall be surfaced using hand squeegees to allow complete and uniform coverage. If necessary, the area to be handworked shall be lightly dampened prior to mix placement. Handwork shall exhibit the same finish as that applied by the spreader and shall be completed prior to final surfacing.
- I. Care shall be taken to apply straight lines along curbs and gutters. No run-off on these areas will be permitted. Roofing felt or heavy plastic may be used to begin or end a pull cleanly.
- J. Rolling is not necessary for slurry seal on roadways. Parking areas shall be rolled by a self-propelled, 10-ton (maximum) pneumatic tire roller equipped with a water spray system. All tires shall be inflated per manufacturer's specifications. Rolling shall not start until the slurry has cured sufficiently to avoid damage by the roller. Areas which require rolling shall receive a minimum of two full coverage passes.

3.03 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to allow a minimum wet film thickness of 15 mils.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Remove and replace or install additional slurry seal mixture where test results or measurements indicate that it does not comply with specified requirements.

3.05 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an Environmental Protection Agency (EPA) approved landfill.

END OF SECTION

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SECTION 32 13 13
SITE CONCRETE WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Portland cement concrete pavement, cement walks, curbs, gutters, trash pick-up area, ramps, mowing strips, fence post footings, sliding gate concrete tracks, catch basins, pipe bedding and encasements, thrust blocks, transition structures, flagpoles and light standard bases and footings, athletic equipment footings and equipment pads.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 35 93 - Off-site Improvement Procedures.
3. Section 01 35 96 - Off-site Improvement Procedures (B-Permit).
4. Section 03 20 00 - Concrete Reinforcement.
5. Division 23 - HVAC.
6. Division 26 - Electrical.
7. Section 31 22 00 - Grading.
8. Section 31 23 16 - Excavation and Fill for Pavement.
9. Section 32 12 16 - Asphalt Paving
10. Section 33 11 00 - Site Water Distribution Utilities.
11. Section 33 30 00 - Site Sanitary Sewer Utilities.
12. Section 33 40 00 - Storm Drainage Utilities.

1.02 SUBMITTALS

- A. Shop Drawings: Submit plans, elevations and details of concrete site Work.
- B. Product Data: Submit mix designs and manufacturer's technical data for materials and products. Submit 3-inch by 3-inch concrete Sample of each specified color.
- C. Material Sample: Submit one concrete bumper to the Project Inspector for destructive testing.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

- C. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
- D. The Contractor shall have one copy of the Standard Specifications at the job site.
- E. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete, Mortar and Related Materials: Comply with applicable provisions of Standard Specifications for Public Works Construction, Section 201 - Concrete, Mortar and Related Materials:
 - 1. Concrete: 28-day compressive strength 2,500 psi, and a maximum of 3,250 psi, unless specified otherwise.
 - 2. Portland Cement: ASTM C 150, Type II, unless noted otherwise.
 - 3. Pozzolan: ASTM C618, Class F or N Fly Ash, 100 pounds maximum per cubic yard, containing one percent or less carbon. Fly ash shall not be used in excess of 15 percent by weight of total cement quantity.
 - 4. Expansion Joint Filler: Preformed expansion joint filler, bituminous type, complying with ASTM D994.
 - 5. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project
 - 6. Combined Aggregates: Gradation "C" conforming to SSPWC Section 201-1.3.2, unless noted otherwise.
 - 7. Water: ASTM C 94/C 94M.
- B. CURING MATERIALS
 - 1. Liquid Curing Compound: ASTM C309, fugitive dye dissipating type, complying with Rule II 13 of the South Coast Air Quality Management District and Federal Air Quality Regulation 40 CFR 52.254.
 - 2. Moisture-Retaining Cover (Curing Sheet): ASTM C 171, non-staining polyethylene film or white burlap-polyethylene sheet.
 - 3. Water: Potable.
 - 4. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- C. STEEL REINFORCEMENT
 - 1. Reinforcing Mesh: ASTM A185, 4 by 4/W1.4 by W1.4 welded wire mesh.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
 - 3. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

- D. Form Materials:
 - 1. Side forms: Douglas fir, Construction Grade or Better or metal forms.
 - 2. Stakes: Douglas fir, Construction Grade or Better or metal stakes.
- E. Concrete Parking Bumpers:
 - 1. Precast concrete, smooth and free of pits and rock pockets, providing a minimum 28-day compressive strength of 3,500 psi. Size at least 7 ½-inch wide, 5 ½-inch high and 6-foot long. Reinforce with two #5 reinforcing bars. Provide 2 ¾-inch diameter pre-drilled holes for anchor installation.
 - 2. Bumper Anchors: Provide ½ inch diameter by 18-inch long galvanized steel pipe.
 - 3. Bumper Adhesive: Provide adhesive recommended by bumper manufacturer/installer for fastening bumpers to concrete pavement.
- F. CONCRETE MIXTURES:
 - 1. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.60, unless noted otherwise.
 - 2. Slump Limit: Four inches, plus or minus one inch, unless noted otherwise.
 - 3. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates to Architect for each batch discharged and used in the Work.

PART 3 EXECUTION

3.01 CONSTRUCTION OF FORMS FOR CAST-IN-PLACE STRUCTURES

- A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
- B. EDGE FORMS AND SCREED CONSTRUCTION
 - 1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
 - 2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
- C. STEEL REINFORCEMENT
 - 1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- D. Concrete Pavement: Install Portland cement concrete pavement in compliance with the Standard Specifications for Public Works Construction, Section 302- Roadway Surfacing.
- E. JOINTS
 - 1. General: Form construction, isolation, and control joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

2. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 4. Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Within 24 hours of pour, construct control joints for a depth equal to a minimum of one inch, or at least one-fourth of the concrete thickness, whichever is greater. Match joints of existing concrete pavement wherever applicable.
 5. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a one-fourth-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
- F. Miscellaneous Exposed Concrete: Install concrete curbs, walks, gutters, cross gutters, access ramps, driveways, catch basins, yard boxes, vaults and similar structures, in compliance with the Standard Specifications for Public Works Construction, Section 303- Concrete and Masonry Construction.
- G. Exposed Concrete Bases: Install bases, such as for post, flagpole, light standards and similar bases, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.
- H. Post, flagpole, light standard footings below grade, underground conduit bedding, encasements, thrust blocks and similar structures may be placed directly in excavations conforming to the required sizes.
- I. Reinforcement installation and concrete placement, surface finishes, curing and removal of forms shall be performed in compliance with applicable provisions of Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction. Provide heavy broom finish at slopes exceeding six percent and medium broom finish at slopes up to six percent.

3.02 INSTALLATION OF PARKING BUMPERS

- A. Install bumpers as indicated on the Drawings. On bituminous paving, install anchors through pavement and into the ground a minimum of 12 inches. On concrete pavement, install bumpers in a continuous bed of adhesive.

3.03 PAVEMENT TOLERANCES

- A. Comply with tolerances as follows
- B. Elevation: One-fourth inch.
- C. Thickness: Plus three-eighths inch minus one-fourth inch.
- D. Surface: Gap below 10-foot long, unleveled straightedge not to exceed one-fourth inch.
- E. Joint Spacing: Three inches.
- F. Contraction Joint Depth: Plus one-fourth inch no minus.
- G. Joint Width: Plus one-eighth inch, no minus.

3.04 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.05 PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.
- C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

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SECTION 32 13 73

CONCRETE PAVEMENT JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and isolation joints within cement concrete pavement.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Compatibility and Adhesion Test Reports: From sealant manufacturer.

1.03 QUALITY ASSURANCE

- A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
 - 1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.03 COLD-APPLIED JOINT SEALANTS

- A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
 - 1. Products:
 - a. Crafcoc Inc.; RoadSaver Silicone.

- b. Dow Corning Corporation; 888.
 - c. Or any equivalent product.
- B. Type SL Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
 - 1. Products:
 - a. Crafcoc Inc.; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Or any equivalent product.

2.04 HOT-APPLIED JOINT SEALANTS

- A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
 - 1. Products:
 - a. Crafcoc Inc.; Superseal 444/777.
 - b. Meadows, W. R., Inc.; Poly-Jet 3406.
 - c. Or any equivalent product.

2.05 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Concrete curing requirement: The concrete must be allowed to cure and dry a minimum of seven days in good drying weather before installing sealant. An additional day of good drying weather must be allowed for each day of poor, inclement weather.
- B. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.
- D. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- E. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- F. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- H. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

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SECTION 32 17 13
PARKING BUMPERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Precast concrete wheel stops.
 2. Resilient wheel stops.

1.02 ACTION SUBMITTALS

- A. Product Data:
1. Precast concrete wheel stops.
 2. Resilient wheel stops.
 3. Resilient-shell, concrete-filled wheel stops
- B. Samples for Verification: For wheel stops, **[6 inches long]** <Insert dimension>, showing color and cross section; with mounting hardware.

PART 2 PRODUCTS

2.01 PARKING BUMPERS

- A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; 4000-psi minimum compressive strength; **[manufacturer's standard height and width]** **[4-1/2 inches high by 9 inches wide]** <Insert dimensions> by **[72 inches]** <Insert dimension> long. Provide chamfered corners[, **transverse drainage slots on underside,**] and a minimum of **[two]** **[three]** factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
 2. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
 3. Surface Sealer: [Manufacturer's standard salt-resistant, clear sealer] <Insert requirement>, applied at precasting location.
 4. Mounting Hardware: Galvanized-steel [spike or dowel, **1/2-inch** diameter, **14-inch** minimum length] [lag screw, shield, and washers; **1/2-inch** diameter, **8-inch** minimum length] [hardware as standard with wheel-stop manufacturer].

- B. Resilient Wheel Stops: Solid, integrally colored [rubber] [or] [plastic]; UV stabilized; [manufacturer's standard height and width] [4 inches high by 6 inches wide] <Insert dimensions> by [72 inches] <Insert dimension> long. Provide chamfered corners and a minimum of [two] [three] [four] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
 2. Color: [Black] [Yellow] [Gray] [Green] [Blue] <Insert color>.
 3. Mounting Hardware: Galvanized-steel [spike or dowel, **1/2-inch** minimum diameter, **14-inch** minimum length] [lag screw, shield, and washers; **1/2-inch** diameter, **8-inch** minimum length] [hardware as standard with wheel-stop manufacturer].
 4. Adhesive: Polyurethane or epoxy, as recommended in writing by wheel-stop manufacturer for adhesion to substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.
- B. Install wheel stops in bed of adhesive before anchoring to substrate.
- C. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Parking stripes, markings and accessibility symbols.
 - 2. Exterior athletic court markings.
 - 3. Playground markings.
 - 4. Fire lane "No Parking."
 - 5. Curb marking and red curbs.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings, indicating location, extent, color and texture of markings.
- B. Material Samples: Submit color Samples.

1.03 PROJECT CONDITIONS

- A. Do not install markings when adverse weather conditions are forecasted.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Paint: Water emulsion-based traffic paint must be approved by OEHS.
 - 1. Dunn Edwards: Vin-L-Stripe.
 - 2. Pervo Paint Company: Acrylic Traffic Paint.
 - 3. Sherwin Williams: Setfast Acrylic Traffic Paint.
 - 4. Vista Paint Corporation: Traffic Paint.
 - 5. Equal.

PART 3 EXECUTION

3.01 PAVEMENT MARKINGS

- A. Application of Paint:

1. Prior to application of paint, allow the pavement to properly cure. Clean and prepare in accordance with paint manufacturer's written recommendations.
2. Provide mechanical equipment to apply paint in a uniform, straight or curved pattern, without gaps, holidays, runs, or other defects.
3. Do not permit traffic until paint has completely cured.
4. Apply two coats in thickness recommended by manufacturer.
5. Playground Markings: Submit Samples to Architect for review. Limited color palettes may be submitted.

B. Marking Width and Color: Unless indicated otherwise, marking width and color are as follows:

Location	Width	Color
Parking stall lines	4 inches	White
Traffic Markings		
Striping:	4 inches	Yellow
General	4 inches	Yellow
Accessible Parking	4 inches	Blue
International Symbol of Accessibility (ITA)	2 inches	White on blue background
Athletic Court Lines:	2 inches	*White
Letters and numbers:		As indicated

*Where two sets of lines overlap, one set shall be white and the other set shall be yellow.

3.02 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 17 26

TACTILE WARNING SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 32 13 13 - Concrete Paving: Concrete sidewalks.
- B. Section 32 17 23.13 - Painted Pavement Markings.

1.03 REFERENCE STANDARDS

- A. 49 CFR 37 - Transportation Services for Individuals with Disabilities (ADA) current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- C. ATBCB PROWAG - Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way 2011.
- D. California Code of Regulations, Title 24, Part 1 - California Administrative Code, Chapter 5, Articles 2, 3, and 4, Most current edition.
- E. California Code of Regulations, Title 24, Part 2 - California Building Code, Chapter 11B, Most current edition.
- F. California Code of Regulations, Title 24, Part 12 - California Referenced Standards Code, Chapter 12-11B, Most current edition.

1.04 SUBMITTALS

- A. See General Condition Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.
- C. Samples: For each product specified provide three (3) samples, 8 inches square, minimum; show actual product, color, and patterns.
- D. Shop Drawings: Submit plan and detail drawings. Indicate:
 - 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
 - 2. Sizes and layout.
 - 3. Pattern spacing and orientation.
 - 4. Attachment and fastener details, if applicable

- E. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
- B. Installer Qualifications: Company certified in writing by product manufacturer as having successfully completed work substantially similar to the work of this section.
- C. Americans with Disabilities Act (ADA): Provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES. In addition, products must comply with CALIFORNIA TITLE 24, PART 2, Chapter 11B, Section 11B-705 requirements regarding patterns, color, and sound on cane contact. In the case of discrepancies, whichever requirement is stricter shall govern.
- D. Polyurethane tactile mat incorporating truncated domes shall conform to the following:
 - 1. Water Absorption of mat when tested by ASTM-D 570 not to exceed 0.36%.
 - 2. Slip Resistance of mat when tested by ASTM-C 1028 the combined wet/dry static coefficient of friction not to be less than 0.90.
 - 3. Tensile Strength of mat when tested by ASTM-D 412 not to be less than 1,100 psi.
 - 4. Tear Strength of Tile when tested by ASTM-D – 624-91 not to be less than 200 psi.
 - 5. Chemical Resistance of mat when tested by ASTM-D-1038: No change.
 - 6. Stain Resistance of mat when tested by ASTM-2299: No change.
 - 7. Smoke Density of mat when tested to ASTM E 662: 245 (@ 4 minutes).
 - 8. Flammability of mat when tested to ASTM E 648: 1.12 watts/ cm. sq.
 - 9. QUV Exposure results when mat tested with "B" Bulbs for 200 hrs.: No change.
 - 10. Freeze-Thaw Cycling when tested to ASTM 1026-84: Unaffected.
 - 11. Hardness of mat when tested to ASTM-D-2240: 90 (Shore A).
 - 12. Specific Gravity of mat when tested to ASTM-D-792: 1.22.
 - 13. Weight loss of mat when tested to ASTM D-1044 (Taber Abrasion H-22 Wheel, 1000gms/1000 cycles) 150 mgs.
- E. Special warnings for disabled persons shall comply with CBC Sections 11B-247.1 and 11B-247.2.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

- C. Mat and adhesive materials shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings, and shall be identified by model designation or number. Mats shall be kept dry and away from sources of heat. Store on flat level surface.
- D. Mat and adhesives shall be delivered to location at building site for storage prior to installation.

1.07 WARRANTY

- A. See General Condition for additional warranty requirements.
- B. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

END OF SECTION

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SECTION 32 18 13
SYNTHETIC TURF SURFACING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.02 SUMMARY

- A. The work under this section shall consist of furnishing all labor, materials, and equipment necessary to install, in place, all synthetic turf and other materials as indicated on the plans and as specified herein. The installation of all new materials shall be performed in strict accordance with these specifications, the turf provider's instructions and in accordance with all details and shop drawings.

1.03 SUBMITTALS

- A. Substitutions: Products other than RootZone 3D3 BLEND 60 are acceptable if in compliance with all requirements of these specifications. Submit alternate products with the bid proposal and provide the following:
 - 1. Provide all specifications, product data, certification and required information for proposed alternate. It is the responsibility of the bidder to prove that the product substitution is equal to or greater than the product specified.
 - 2. Provide a sample copy of insured warranty and insurance policy information.
 - 3. Provide a sample (8.5" x 11") of the product substitution.
- B. Product Data: For each type of product indicated.
 - 1. Submit catalog cuts, material safety data sheets (MSDS), brochures, specifications, preparation and installation instructions and recommendations.
 - 2. All supplied and installed materials and products will meet or exceed the minimum specifications designated in this section. Sufficient data must be submitted to indicate compliance with the Contract Documents.
 - 3. Submit instructions for installation.
- C. Test Results: The following test results, certified by a licensed independent testing laboratory, shall be submitted as outlined below:
 - 1. With the bid – Mandatory and minimum specifications as shown in Part 2. Bids not meeting the minimum specifications will be rejected.
 - 2. Upon completion of the installation of the infill (including anti-static applications)— Installer Supervisor must measure and record infill depth using a depth tester for Turf and Tracks with analog or digital readout. At ten separate field locations, three data points should be recorded by measuring the infill depth in a triangular pattern approximately 12" – 18" apart. At each of the ten testing locations, the three data points should be averaged. Any location that does not measure 1.46" in depth or more must be corrected.

3. At completion of project – Dynamic Cushioning Test according to ASTM F-355-95, Procedure A and Standard F-1936-98 only if the finished product is to be used for American Football.
- D. Shop Drawings: Show fabrication and installation details for synthetic turf including, but not limited to:
1. Proposed locations of all seams in fabric surfacing. Show installation methods and construction.
 2. Field lining and marking - Submit a complete scale and dimensional drawing of inlaid or tufted-in field lines and marking boundaries. Include graphics for end zones and center logo artwork for approval as well.
 3. All submittals shall be provided within 14 days after Notice to Proceed
- E. The Turf Manufacturer shall provide the following samples of the artificial turf selected for this project:
1. An 8.5" x 11" minimum sample of the exact synthetic turf and infill system that is specified for this project.
 2. Infill mix in accordance with product specifications
- F. Turf Manufacturer Certificates: Certified list of fifty (50) existing installations of a synthetic turf and infill system within the last three years, including Owner Representative and telephone number, attesting compliance with quality assurance information. All must be located within the continental United States.
- G. With the bid - Proof that the Turf Manufacturer is a member, in good standing, of the Synthetic Turf Council
- H. With the bid – Sample Warranty: Provide a sample pre-paid third party insured warranty with the bid. Policy must be in force at the time of the bid.
1. The Contractor shall provide a warranty to the Owner that covers defects in materials and installation workmanship of the turf for a period of ten (10) years from the date of substantial completion. The turf provider must verify that their representative has inspected the installation and that the work conforms to the turf provider's requirements and any written directives. The warranty shall include general wear and damage caused by UV degradation. Other items that must be addressed include the following:
 - a. Acceptable uses for the field
 - b. Fading
 - c. Color match within specifications.
 - d. Excessive fiber wear
 - e. Wrinkling and panel movement
 - f. Shock absorbency (Gmax)
 - g. Seam integrity
 - h. Drainage (through the turf only)
 2. Exclusions shall include the following:
 - a. Vandalism
 - b. Acts of God

3. The warranty shall be fully third-party insured for the first 8-Years and be non-prorated. Warranties that include language which pro-rates benefits shall cause the provider's bid to be rejected. Prior to final payment for the synthetic turf, the Contractor shall submit to the Owner, this policy guaranteeing the warranty to the Owner. Insurance must reflect the following values:
 - a. \$5,000,000 per each insured warranty
 - b. \$5,000,000 annual aggregate for all warranties issued during each 12-month period of the 8-Year third-party insured warranty.
 - c. Policies that are backed by a Letter of Credit are not acceptable.
 - d. Policy must be issued by an A- rated or greater A.M. Best Rating
 - e. Policies that include self-insurance or self-retention clauses shall not be considered. Policy cannot include any form of deductible amount. Policy must be in force at the time of the bid.
- I. With the bid – Turf Manufacturer must attest that their submitted products infringe on no known patents.
- J. Maintenance and Operations Data: At the completion and acceptance of the project submit 3 complete sets, in manual form, of all the turf provider's recommended procedures and materials for, but not limited to general maintenance, line/marketing installation, small repair procedures, cleaning, etc.
- K. Project Record Documents: Record actual locations of seams, drains, and other pertinent information in accordance with the General Requirements

1.04 QUALITY ASSURANCE

- A. Turf Manufacturer Qualifications
 1. Shall be experienced in the installation of synthetic infill grass (including in-house factory extruded nylon RootZone® fiber) for a minimum of five (5) years.
 2. Shall have a minimum of 500 full sized tall fiber infilled type field installations. Field size to be a minimum of 65,000 square feet to qualify. This list is to be provided with the bid.
 3. Shall provide third party certification confirming compliance with referenced standards.
 4. Turf Manufacture must formulate and produce its own fiber master batch.
- B. Installer Qualifications:
 1. The installation team shall be an established, insured installation firm experienced as a premium turf installer with suitable equipment and supervisory personnel, with a minimum of five years' experience with 15-foot-wide tufted materials.
 2. The installation team shall be trained and certified, in writing, by the turf manufacturer, as competent in the installation of the specified material, including seaming and proper installation of the infill mixture.
 3. The site superintendent shall have at least 10 installations that are similar to this type of tall fiber synthetic turf system.
- C. All components and their installation method shall be designed and manufactured for use on outdoor athletic fields. The materials as hereinafter specified, should be able to withstand full climatic exposure, be resistant to insect infestation, rot, fungus and mildew; to ultra-violet light

and heat degradation, and shall have the basic characteristic of flowthrough drainage allowing free movement of surface run-off through the turf and directly into prepared granular base and into the field drainage system.

- D. The synthetic turf and components shall be of national reputation. The turf fabric shall be installed by factory-authorized and certified technicians.

1.05 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit synthetic turf work to be performed according to Contractor or Turf Provider's written instructions and warranty requirements.
- B. Field Measurements: Indicate measurements on Shop Drawings.

1.06 WARRANTY

- A. Special warranty for American Football: Turf must maintain an ASTM F 355 Gmax of less than 165 for the life of the warranty. This is for the entire warranty period of ten (10) years.

1.07 MAINTENANCE SERVICE

- A. Turf Installation Contractor shall train maintenance staff and/or contracted maintenance staff in the use of the recommended maintenance equipment and provide maintenance guidelines to the facility maintenance staff.
- B. Annual Manufacturer Certified Maintenance plan for life of warranty (10 years) must be provided. Must include, but not limited to, a minimum of 1 visit per year with the following services performed:
 - 1. Full Field Inspection
 - 2. Entire Field Grooming
 - 3. Magnetic Metal Collecting
 - 4. Professional Cleaning
 - 5. Disinfectant application
 - 6. Owner Maintenance procedure review

PART 2 PRODUCTS

2.01 ACCEPTABLE TURF MANUFACTURERS

- A. Pre-Approved turf manufacturer:
 - 1. AstroTurf Corporation – AstroTurf® Rootzone 3D3 BLEND 60
2680 Abutment Road, SE
Dalton, GA 30721
P: 706.277.8873
 - 2. Alternate provider is acceptable and must meet and/or be equivalent to all listed requirements, qualifications, and specifications.

2.02 TURF MATERIALS

- A. Synthetic Turf System: A complete synthetic turf system consisting of a combination of 10,800 denier monofilament fibers made from a singularly extruded combination of stabilized polyethylene and nylon polymers with proper compatibilizers and 10,000 denier parallel slit film fibers along with an in-house factory extruded monofilament nylon RootZone®. Pile height shall be nominal 2.0". Fibers shall be tufted to a primary backing and a mechanically applied adhesive secondary backing.
1. The tufted fiber's face weight shall not weigh less than 60 ounces per square yard. The tufted rows of fiber are to be spaced no more than 3/8" apart. ASTM tests proving the fiber meets these qualifications must be provided with the bid. Turf systems that do not meet this specification will be disqualified.
 2. The carpet's primary backing shall have a minimum weight of 6.7 oz per square yard. The carpet shall then be coated with a secondary backing of polyurethane synthetic coating material with a minimum application rate of 20 ounces per square yard and then perforated for adequate drainage. Carpets that are not perforated for adequate drainage shall not be acceptable.
 3. The carpet shall be delivered in 15' wide rolls. The rolls shall be of sufficient length to go from sideline to sideline. Head seams, other than at sidelines, will not be acceptable.
- B. The infilled pile surface shall provide good traction in all types of weather with the use of conventional sneaker type shoes, composition molded sole athletic shoes, and screw- in style football cleats.
- C. The pile surface shall be suitable for both temporary and permanent line markings using acrylic paint, as per the turf provider's recommendations.
- D. All adhesives used in bonding the seams shall be resistant to moisture, freeze/thaw, bacteria and fungus attacks, and resistant to ultraviolet radiation. The adhesive shall be made especially for the adhesion of synthetic turf seams and inlaid field markings and graphics.
- E. The seam specific adhesive system shall have been utilized on at least 25 full installations. Provide this information with the bid. It shall consist of a factory-made adhesive bed applied to a non-woven fabric seaming tape. The adhesive bed shall be a metered amount suitable for the application. It shall be heat and pressure activated. A special heat application machine and pressure application using weighted rollers is mandatory.
- F. Supply field groomer and sweeper or single maintenance apparatus that performs both basic maintenance functions.
- G. Perimeter edge details required for the system shall be as detailed and recommended by the turf provider, and as approved by the turf provider.

2.03 TURF FABRIC SURFACE

- A. The pile surface shall resemble freshly mown natural grass in appearance, texture and color.
- B. The pile surface shall be nominally uniform in length.
- C. The pile fiber angle shall be 90 degrees \pm 15 degrees, measured from the horizontal after installation of the infill material.
- D. The entire system shall be resistant to weather, insects, rot, mildew, and fungus growth and will be non-allergic and non-toxic.
- E. The synthetic turf system shall have a nominal fiber length of 2.0".

- F. Each roll shall be minimum 15' wide.
- G. The entire system shall be constructed for porous standards as specified. Synthetic turf system shall be perforated at 4 – 6" on center. Systems that are not perforated for maximum drainage shall not be acceptable.
- H. All markings shall be tufted in-place, inlaid or glued. It is recommended that the maximum amount of markings be factory-prefabricated into the turf system prior to shipment to site. At a minimum all football markings (except for hash marks) must be factory prefabricated.

2.04 PRODUCT SPECIFICATIONS - TURF

- A. Face yarns shall be a combination of:
 1. A proven athletic quality, outdoor stabilized blend of non-texturized monofilament yarn with a minimum of 330-micron thickness used with parallel slit film polyethylene fibers and;
 2. An in-house factory extruded texturized monofilament nylon RootZone designed specifically for outdoor use, to best resist the effects of ultraviolet degradation, heat, foot traffic, water, and airborne pollutants.
- B. The fabric shall possess the following minimum physical characteristics. ASTM testing shall be provided with the bid and any products not meeting the minimum physical characteristics will be rejected:

Average Pile Yarn Face Weight	ASTM D 5848	60 oz/square yard
Average Total Weight	ASTM D 5848	86.7 oz/square yard
Secondary Backing Weight	ASTM D 5848	20 oz/square yard
Primary Backing	ASTM D 5848	6.7 oz/square yard
Average Tuft Length	ASTM D 5823	2.00"
Tufting Gauge	ASTM D 5793	3/8" maximum
Tuft Bind	ASTM D 1335	> 8 lbs
Yarn Denier (monofilament fiber)	ASTM D 1577	10,800 / 6
Yarn Denier (slit film fiber)	ASTM D 1577	10,000/1
Yarn Denier (secondary fiber)	ASTM D 1577	6,000/8
Fiber Thickness (primary/secondary)	ASTM D 3218	330 / 100 microns
Surface Flammability	ASTM D 2859	8 of 8 PASS
Permeability	ASTM F 1551	>30
Melt Point	ASTM D 789	248 degrees F
Gmax System (American Football)	ASTM F 355	<125 at installation, <165 over life of warranty.

2.05 INFILL MATERIAL

- A. Infill composition shall consist of a ballast layer of silica sand topped by EPDM rubber and Zeolite infill in a ratio by weight of EPDM 1 lb/sqft, Zeolite 1 lb/sqft and silica sand 3.5 lbs/sqft.
- B. Silica sand infill:

1. Must be clean, sub-angular silica sand.
 2. Must be a 20-40 sieve size.
- C. Zeolite infill:
1. Must be clean, uniform particle.
 2. Must be mined in Death Valley, CA (KMI)
- D. EPDM Rubber Infill:
1. Must be 100% virgin Material.
 2. Must be a .5mm – 1.5mm sieve size.
 3. Must be provided by the synthetic turf manufacturer.
- E. Immediately after infill layers are installed, infill depth must be measured per testing protocol detailed in Section 1.3 C. 2 above to ensure that infill layer is at least 1.46” deep.

2.06 SHOCK PAD MATERIALS

- A. A shock pad is required for impact attenuation.
- B. Shock Pad must be approved by turf provider for use under the specified turf system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installation of the synthetic turf, examine substrates and conditions, with Installer present, for compliance with requirements for visual installation tolerances. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Certification of prior work: The synthetic turf manufacturer and / or certified installation contractor shall perform a visual inspection of the field base onto which the synthetic turf system is to be installed and to examine the finished surface for required compaction, and grade tolerances (through string line testing). After any discrepancies between the required materials, application and tolerance requirements noted have been corrected, the synthetic turf installer should submit a written certification of VISUAL acceptance of the base for installation of the synthetic turf system. Any tests other than VISUAL tests (string line, water hose, etc...) shall be the responsibility of the General Contractor, Architect, Engineer, or Sports Field Consultant.
- C. Installation of all materials shall be performed in full compliance with approved project shop drawings. Only factory trained and certified technicians skilled in the installation of athletic caliber synthetic turf systems, working under the direct supervision of the turf manufacturer's project managers, shall undertake the placement of the turf system. The designated supervisory personnel on the project must be certified, in writing by the turf provider as competent in the installation of these materials, including proper seaming and proper installation of the infill mixture. The turf provider shall certify the installation and warranty compliance.

3.02 PREPARATION

- A. Inspect delivered field surface fabric and components immediately prior to installation. Any damaged or defective items shall be rejected. Installed synthetic turf system shall be inspected for, but not limited to, the following:

1. Uniformity of product and color
 2. Surface wrinkles
 3. Field markings
 4. Field Edge installation
 5. Pile height of each roll shall be measured. Any material(s) that does not meet minimum height and thickness specifications shall be rejected. Pile height shall be measured in its finished positions.
- B. Environmental Conditions: Weather conditions are important for the successful installation of the systems. No work under this section will proceed when:
1. Ambient temperatures are below 45 degrees F.
 2. Material temperatures are below 45 degrees F.
 3. Surfaces are wet or damp
 4. Rain is imminent or falling.
 5. Conditions exist or are imminent, which will be unsuitable to installation requirements of the systems specified herein. Humidity levels will be inside the limits recommended by the adhesive manufacturer to obtain optimal bonding characteristics of the surfaces.

3.03 INSTALLATION OF THE SYNTHETIC TURF

- A. The full width rolls shall be laid out across the field. When all of the rolls of the playing surface have been installed, the sideline areas will be installed at right angles to the playing field turf. All seam widths are to be held to a minimum and shall be traverse to the field direction. Seams shall be flat, tight, and permanent with no separation or fraying. All seams shall remain as required for the duration of the warranty period.
- B. The perimeter of the field shall be firmly secured to the edge anchors for the life of the warranty and in accordance to project details.
- C. Resilient Infill
1. The sand ballast infill material shall be spot inspected and tested for conformance to sieve specifications.
 2. Sand ballast Infill must be placed in such a way as to minimize fiber entrapment.
 3. The rubber infill must be uniformly applied so as to ensure uniform, predictable surface.
 4. After infill layers are installed, infill depth must be measured to ensure that infill depth is at least 1.46" deep.

3.04 FIELD LINING AND MARKINGS

- A. All markings shall be installed in accordance with prior approved project Shop Drawings.
- B. Inlays shall conform to the turf manufacturer's specifications, directions, and recommendations for the best results.
- C. Striping layouts shall be accurately measured by the Contractor before installation of inlaid field markings.
- D. Install inlays only when the surface is completely dry. Adhere all inlays securely into place. Never loose-lay and sew an inlay into place.

3.05 FIELD QUALITY CONTROL—TESTING AGENCY:

- A. Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing and inspecting of completed applications of synthetic turf system shall take place in suggestive states, in areas of extent and using methods that are industry standard. Do not proceed with application of next stages until test results for previously completed applications show compliance.
- C. Remove and replace items where test results indicate that they do not comply with specified requirements.

3.06 FINAL ACCEPTANCE

- A. Upon final acceptance, the Manufacturer shall submit to the Owner three (3) copies of Maintenance Manuals, which will include all necessary instructions for the proper care and preventative maintenance of the synthetic turf system, including painting and striping.
- B. The Manufacturer shall ensure that the turf can be plowed with Manufacturer approved snow removal equipment as detailed in the provided Maintenance Manuals.
- C. The finished playing surface shall appear as mowed grass with no irregularities and shall afford excellent traction for conventional athletic shoes of all types. The finished surface shall resist abrasion and cutting from normal use.

3.07 CLEANING

- A. The contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items. All usable remnants of new material shall become the property of the Owner. The Contractor shall keep the area clean throughout the project and clear of debris. Surfaces, recesses, enclosures, etc., shall be cleaned, as necessary, to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

END OF SECTION

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SECTION 32 31 13

CHAIN-LINK FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases; concrete foundation for posts.
- C. Manual gates and related hardware.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with CLEFMI – Product Manual.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

1.05 ACTION SUBMITTALS

- A. Product Data: Within 35 calendar days after the Contractor has received the District's Notice to Proceed, submit:
 - 1. Materials list and cut sheets of items proposed to be provided under this Section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 3. Shop drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades; do not use architect's drawings. If heights are not indicated on drawings, fencing shall be 8'- 0" high.
 - 4. The manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures for the Work.

PART 2 PRODUCTS

2.01 CHAIN-LINK FENCING AND GATES

- A. General: Where vinyl coated fabric is called for on the drawings, also provide color coated framing, posts, rails, and associated items. Similarly, where galvanized fabric is indicated, associated framing and accessories shall be galvanized.

1. Pipe sizes indicated are commercial pipe sizes.
2. Tube sizes indicated are nominal outside dimensions.

2.02 GALVANIZING

- A. On steel framework and appurtenances, provide galvanized finish with not less than the following weight of zinc per sq. ft. Typical.
 1. Pipe: 1.8 oz, complying with ASTM A120.
 2. Square Tubing: 2 oz, complying with ASTM A123.
 3. Hardware and Accessories: Comply with table II of ASTM A121.
 4. Fabric: 2.0 oz, complying with class II of ASTM A121.

2.03 FABRIC

- A. Provide galvanized 9-gauge wire and 0.148" vinyl coated wire in 2" mesh (or 1" where indicated on drawings), with top and bottom salvages twisted and knuckled. Galvanized finish where indicated on the drawings. Vinyl coated finishes shall be in the color selected by the Architect. Provide fabric in one-piece widths.

2.04 POSTS, RAIL, AND ASSOCIATED ITEMS

- A. End, Corner, Slope, and Pull Posts:
 1. Provide at least the following minimum sizes and weight:

Material and Dimensions	lbs/ft.
a. Pipe, 4" Outside Dimension	10.8
 2. From 8'-1" to 17'-0" high fence, end & corner posts shall be 6" diameter pipes, 19 lbs/ft
 3. From 17'-1" to 20'-6" high fence, end & corner posts shall be 8" diameter pipes, 28.60 lbs/ft.
 4. Finish: Vinyl Coated : Color selected by the Architect Galvanized finish (where indicated on drawings)
- B. Line Posts:
 1. Provide minimum sizes and weights as follows:

Material and Dimensions	lbs per liner ft.
a. Pipe, 4" Outside Dimensions	10.8
 2. From 8'-1" to 17'-0" high fence, end & corner posts shall be 6" diameter pipes, 19 lbs/ft
 3. From 17'-1" to 20'-6" high fence, end & corner posts shall be 8" diameter pipes, 28.60 lbs/ft.
 4. Finish: Vinyl Coated : Color as Selected by the Architect or Galvanized finish (where indicated on drawings)
- C. Gate Posts:
 1. Provide gate posts for supporting single gate leaf, or one leaf on a double gate installation, for nominal gate widths as follows:

Material and Dimensions	lbs per lin ft
-------------------------	----------------

- a. Pipe, 4" Outside Dimension, 10.8 lbs/ft.
 2. Vinyl Coated: Green or Galvanized Finish (where indicated on drawings)
 3. Over 13 feet wide, and up to 18 feet wide: Use 6.625" outside diameter pipe weighing 14.0 lbs per lin ft.
 4. Over 18 Feet Wide: Use 8.625" outside diameter pipe weighing 24.70 lbs per lin ft.
- D. Top Rails:
1. Use 1.9" outside diameter pipe weighing 2.72 lbs per lineal ft. vinyl coated; or
 2. Provide in manufacturer's longest lengths, with expansion type couplings approximately 6" long for each joint.
 3. Provide means for attaching top rail securely to each gate, corner, pull, slope and end post.
- E. Post Brace Assemblies:
1. Provide at end and gate posts, and at both sides of corner, slope, and pull posts, with the horizontal brace located at mid-height of the fabric.
 2. Use 1.9" diameter pipe weighing 2.72 lbs per lineal ft. vinyl coated for horizontal brace.
 3. Use 3/8" diameter rod with turnbuckle for diagonal truss.
- F. Tension Wire: Provide 7-gauge galvanized vinyl coated coiled spring wire at bottom of fabric.
- G. Post Tops:
1. Provide single piece steel, wrought iron, or malleable iron, Vinyl coated designed as weathertight closure cap.
 2. Provide one cap for each post.
 3. Provide caps with openings to permit passage of top rail.
- H. Stretcher Bars:
1. Provide one-piece lengths equal to full height of fabric, with a minimum cross-section of 3/16" x 3/4".
 2. Provide one stretcher bar for each gate and end post, and two for each corner, slope, and pull post, except where fabric is woven integrally into the post.
- I. Stretcher Bar Bend:
1. Provide steel, wrought iron, or malleable iron, spaced not over 15" on centers, to secure stretcher bars to end, corner, pull, slope, and gate posts.
 2. Bands may be used also with special fittings for securing rails to end, corner, pull, slope, and gate posts.
- 2.05 GATES-SWINGING AND ROLLING
- A. General:
1. Fabricate gate perimeter frames of tubular members.
 2. Provide additional horizontal and vertical members to assure proper operation of the gate and for attachment of fabric, hardware, and accessories.
 3. Space so frame members are not more than 8 feet apart.

4. Fabricate Gate Frames from:
 - a. Materials and Dimensions: lbs per lineal ft.
 - b. Pipe 1.90" Outside Diameter: 2.72
 - c. Tubing, 2" Square: 2.60

- B. Fabrication:
 1. Assemble gate frames by welding them with special malleable or pressed steel fittings and rivets for rigid connections.
 2. Use same fabric as used in the fence.
 3. Install fabric with stretcher bars at vertical edges as a minimum.
 4. Attach stretchers to gate frame not more than 15" on centers.
 5. Attach hardware with rivets or by other means which will provide security against removal and breakage.
 6. Provide diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on gates where required to provide frame rigidity without sag or twist.

- C. Swinging Gate Hardware:
 1. Provide following for each gate:
 - a. Hinges:
 - 1) Pressed or forged steel, or malleable iron, to suite the gate size; non-lift-off type, offset to permit 180-degree opening.
 - 2) Provide 1-1/2 pair of hinges for each leaf over 6 feet in nominal height.
 - b. Latches:
 - 1) Provide forked type to permit operation from either side of the gate. Plunger-bar type is not acceptable.
 - 2) Provide padlock eye as integral part of latch.
 - c. Keeper: Provide keeper for vehicle gates, which automatically en gauges the gate leaf and holds it in the open position until manually released.
 - d. Double Gates:
 - 1) Provide gate stops for double gates consisting of mushroom or flush plate, with anchors.
 - 2) Set in concrete to en gauge the center drop rod or plunger bar.
 - 3) Provide locking device and padlock eyes an integral part of the latch, requiring one padlock for locking both gate leaves.
 - e. Gates: Gates in path of travel across an exit to a public way or to a safe dispersal area must comply with exit door hardware and shall have Panic hardware and lever handled latches, (CBC Section 1133B.1.1.1.4). Hardware shall not require pinching, grasping or twisting motion to operate and provide solid kick plates 10" minimum high 3" maximum from paving on both sides of the gate. Gates shall also have a 5 lb. maximum opening pressure and door maneuvering clearance.

- D. Rolling Gate Hardware:
 1. Provide the Following for Each Gate:

- a. Latches:
 - 1) Provide forked type or plunger-bar type to permit operation from either side of the gate.
 - 2) Provide padlock eye as integral part of latch.
 - 3) Mounting height 30"-44" A.F.F.
- b. Universal Track Bracket: Provide 10-gauge galvanized steel brackets with 3/8" diameter galvanized J-Bolts and nuts.
- c. Rear Wheels:
 - 1) Provide 5" outside diameter, 4" diameter V-Groove, galvanized steel roller bearing wheel.
 - 2) Anchor rear wheels to gate frame with 5/8" diameter bolts.
- d. Double Wheel Carriage: Provide 1" x 2" x 14 ga galvanizing steel tube axle with 3/8" diameter galvanized J-Bolts and 6" diameter rubber tire with galvanized steel roller bearing hub.
- e. Provide locking device and padlock eyes as an integral part of the latch.

2.06 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Wire Ties:

- 1. For tying fabric to line posts, use 9-gauge galvanized wire ties spaced 12" on center.
- 2. For tying fabric to rails and braces, use 9-gauge galvanized wire ties spaced 24" on center.
- 3. For tying fabric to tension wire, use 11 gauge galvanized hot rings spaced 24" on center.
- 4. The manufacturer's standard wire ties will be acceptable if of equal strength and durability.

B. Concrete: Comply with provisions of Section 033000 for 2500 psi concrete.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. General:

- 1. Install posts at a maximum spacing of 8 feet on center.
- 2. Install corner or slope posts where changes in line or grade exceed a 30-degree deflection.

B. Excavating:

- 1. Drill holes for post footing in firm, undisturbed or compacted soil, strictly adhering to the dimension and spacing shown.

2. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the site if so directed.
3. When soil from rock is encountered near the surface, drill into rock at least 12" for line posts and at least 18" for end, pull gate, and corner posts. Drill hole at least 1" greater diameter than the largest dimension of the post to be placed.
4. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed minimum depths as specified above.

C. Setting Posts:

1. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
2. Center and align posts in hole.
3. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
4. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
5. Trowel tops of footings, and slope or dome to direct water away from posts.
6. Extend footings for gate posts to the underside of bottom hinge.
7. Set keeps, stops, sleeves, and other accessories into concrete as required.
8. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing material or other curing method accepted by the Architect.
9. Grout-in those posts which are set into sleeved holes concrete constructions, or rock excavations, using non-shrink portland cement grout or other grouting material accepted by the Architect.

D. Concrete Strength:

1. Allow concrete to attain at least 7% of its minimum 28-day strength before rails, tension wires, and/or fabric is installed.
2. Do not, in any case, install such items in less than seven days after placement of concrete.
3. Do not stretch and tension fabric and wire, and do not hang gates, until concrete has attained its full design strength.

E. Rails and Bracing:

1. Install fence with a top rail and bottom tension wire.
2. Install top rails continuously through post caps or extension arms, bending to radius for curved runs.
3. Provide expansion couplings as recommended by the fencing manufacturer.
4. Provide bracing to the midpoint of the nearest line post or posts at all ends, corner, slope, pull and gate posts.
5. Install tension wires parallel to the line of fabric by weaving through the fabric and tying each post with not less than 6-gauge galvanized wire, or by securing the wire to the fabric.

F. Installing Fabric:

1. Leave approximately 2" between finish grade and bottom salvage.

2. Excavate high points in the ground to clear the bottom of the fence.
 3. Place and compact fill to within 1" of the bottom of the fabric in depressions if no mow curb.
 4. Pull fabric taut and tie to posts, rails, and tension wires.
 5. Install fabric on outward side facing side of fence, and anchor to framework so that the fabric remains in tension after pulling force is removed.
 6. Install stretcher bars by threading through or clamping to fabric on 4" centers, and secure to posts with bands spaced 15" on centers.
- G. Installing Gates:
1. Install gates plumb, level, and secure for full opening without interference.
 2. Install ground-set items in concrete for anchorage in accordance with the fence manufacturer's recommendations as accepted by the Architect.
 3. Lubricate and adjust the hardware for smooth operation.
- H. Miscellaneous:
1. Use U-shaped tie wires, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
 2. Bend ends of wire to minimize hazards to persons and clothing.
 3. Fasteners:
 - a. Install nuts from tension band and hardware bolts on side of fence opposite fabric side.
 - b. Peen the ends of bolts to prevent removal of nuts.
 4. Repair coatings damaged in the shop or field erection, using a hot-applied repair compound applied in accordance with its manufacturer's recommendations as accepted by the Architect.

END OF SECTION

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SECTION 32 33 00

SITE FURNISHINGS

PART 1 GENERAL

1.01 DESIGN REQUIREMENTS:

- A. Designer shall consult College Facility Director for final selections.
- B. Designer shall review and adapt most current College Master Plan, Facility Master Plan and College Design Standards to establish basis of design.
- C. All furniture shall meet current ADA requirements.
- D. All furniture shall be secured by anchoring, placed inside a secure enclosure, or embedded into the ground/floor to prevent thief.
- E. All furniture shall have a minimum of 3-years full warranty (including discoloring) and 9 years warranty on material.
- F. All benches shall have metal handlebars or divider in the middle with spacing not to exceed 42" to prevent horizontal occupancy.
- G. Apply anti-graffiti coating if requested by the Owner.
- H. Possible material for tables, chair and benches are:
 - 1. Hard Plastic.
 - 2. Concrete.
 - 3. Metal – aluminum preferred.
- I. No wooden products of any kind.
- J. Sample Products: Wausau Tile concrete & metal tables as well as trash receptacles and benches.
 - 1. Concrete tables
 - a. ADA 3-seater options
 - b. 2-seater tables for above grade installation - non-anchoring
 - 2. Bench
- K. No fiber glass umbrellas shall be used.
- L. Fabric umbrellas shall be avoided unless requested by the Campus Facility Director.
- M. All litter receptables and trash enclosures shall be screened with landscaping whenever possible.

END OF SECTION

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SECTION 32 84 00
PLANTING IRRIGATION

PART 1 GENERAL

1.01 DESCRIPTION:

- A. Division 1 applies to this Section. Provide all labor, materials, appliances, tools, equipment, facilities, transportation, and services necessary for and incidental to performing all operations in connection with furnishing, delivery, and installation of the Work of this Section, complete as shown on the Drawings and/or specified herein.
- B. Work in This Section: Principal items include:
 - 1. Irrigation mains.
 - 2. Laterals.
 - 3. Sprinkler heads.
 - 4. Control valves.
 - 5. Coupler valves, etc.
 - 6. Automatic controllers.
- C. Related Work Not in This Section: Examine all Sections for Work related to Work of this Section; principal items of which are:
 - 1. Operation and Maintenance of Site Improvements – Section 32 01 30
 - 2. Drip Irrigation – Section 32 84 13
 - 3. Planting – Section 32 90 00
- D. Definition: The word Architect as used herein shall refer to the Landscape Architect or the Owner.

1.02 ASSURANCE AND REQUIREMENTS:

- A. Permits and Fees: Contractor shall obtain and pay for all permits and all inspections as required.
- B. Manufacturer's Directions: The manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the Drawings and Specifications.
- C. Ordinances and Regulations: All local, municipal, and state laws, and rules and regulations governing or relating to any portion of this Work are hereby incorporated into and made a part of these Specifications, and their provisions shall be carried out by the Contractor. Anything contained in these Specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these Specifications and Drawings call for, or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these Specifications and Drawings shall take precedence.

D. Explanation of Drawings:

1. Due to the scale of the Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his Work and plan his Work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. Drawings are diagrammatic and indicative of the Work to be installed. The Work shall be installed in such a manner as to avoid conflicts between Irrigation systems, planting, and architectural features.
2. All Work called for on the Drawings by notes or details shall be furnished and installed whether or not specifically mentioned in Specifications.
3. Contractor shall not willfully install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in the engineering. Such obstructions or differences should be brought to the attention of the Owner's authorized representative. In the event this notification is not performed, Contractor shall assume full responsibility for any revision necessary.
4. Work of this Section which is allied with the Work of other trades shall be coordinated as necessary.

E. Underwriters Laboratories: Electrical wiring, controls, motors, and devices shall be UL listed and so labeled.

1.03 DESIGN

- A. New irrigation system shall be designed to accommodate future reclaimed water connections to municipal water sources, campus rainwater harvesting, or greywater reuse systems.

1.04 SUBMITTALS:

- A. Refer to the General Conditions for procedures.

B. Materials List:

1. The Contractor shall furnish the articles, equipment, materials, or processes specified by name in Drawings and Specifications. No substitutions will be allowed without prior written acceptance by the Architect.
2. Complete material list shall be submitted prior to performing any Work. Material list shall include manufacturer, model number, and description of all materials and equipment to be used.
3. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor requested to remove such materials from the site at his own expense.
4. Approval of any item, alternate, or substitute indicated only that the product or products apparently meet the requirements of the Drawings and Specifications of the basis of the information or samples submitted.
5. Manufacturer's warranties shall not relieve Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
6. If equipment is as specified, no manufacturer descriptive catalogs are necessary in submittal.

C. Record Drawings:

1. Contractor shall provide and keep up to date and complete "as-built" record set of blue-line prints or CADD files which shall be corrected daily and shown every change from the original Drawings and Specifications and exact "as-built" locations, sizes, and kinds of equipment. Prints for these purposes may be obtained from the Architect at cost. This set of Drawings shall be kept on the site and shall be used only as a record set.
2. These Drawings shall also serve as Work progress sheets and shall be the basis for measurement and payment for Work completed. These Drawings shall be available at all times for site reviews and shall be kept in a location designated by the Architect. Should the record blue-line or CADD file as-built progress sheets not be available for review or not up to date at the time of any site reviews, it will be assumed that no Work has been completed and the Contractor will be assessed the cost of that site visit at the current billing rate of the Architect. No other inspections shall take place prior to payment of that assessment.
3. The Contractor shall make neat and legible notations on the as-built progress sheets daily as Work proceeds, showing the Work as actually installed. For example, should a piece of equipment be installed in a location that does not match the plan, the Contractor must indicate that equipment has been relocated in a graphic manner so as to match the original symbols as indicated in the irrigation legend. The relocated equipment and dimensions will then be transferred to the original as built plan at the proper time.
4. Before the date of the final site review, Contractor shall create a transparency or CADD drawing showing all information from the as-built prints. The dimensions shall be made so as to be easily readable even on the final controller chart (See section C below).
5. The Contractor shall dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:
 - a. Connection to existing water lines.
 - b. Connection to existing electrical power.
 - c. Gate valves.
 - d. Routing of sprinkler pressure lines. (Dimension max. 100' along routing.)
 - e. Sprinkler control valves.
 - f. Routing of control wiring.
 - g. Quick coupling valves.
 - h. Other related equipment as directed by the Architect.
6. On or before the date of the final site review, the Contractor shall deliver the corrected and completed transparencies or CADD drawings to the Architect. Delivery will not relieve the Contractor of the responsibility of furnishing required information that may be omitted from the Drawings.

D. Controller Charts:

1. Record Drawings shall be approved by the Architect before controller charts are prepared.
2. Provide one controller chart for each controller supplied.
3. The chart shall show the area controlled by the automatic controller and shall be the maximum size which the controller door will allow.
4. The chart is to be a reduced drawing of the actual as-built system, of a maximum size that will fit inside controller housing, double sided if required for readability.

5. The chart shall be a blackline print and a different color shall be used to indicate area of coverage for each station, using pastel or transparent colors.
6. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils.
7. These charts shall be completed and approved prior to final acceptance of the irrigation system.

E. Operation and Maintenance Manuals:

1. Prepare and deliver to the Architect within 10 calendar days prior to completion of construction, two hard cover binders with three rings containing the following information:
 - a. Index sheets stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representative.
 - b. Catalog and part sheets on all materials and equipment installed under this Contract.
 - c. Guarantee statement.
 - d. Complete operating and maintenance instruction on all major equipment.
2. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for major equipment, and show evidence in writing to the Architect at the conclusion of the project that this service has been rendered.

F. Equipment to Be Furnished:

1. At time of final acceptance, Irrigation Contractor shall deliver to the Owner:
 - a. Two keys for opening valve boxes.
 - b. Two keys for each automatic controller.
 - c. Hose and Swivel Assemblies: Supply one (1) set of hose and swivel assemblies for every five (5) quick coupling valves installed.
 - d. Two special wrenches suitable for operating each type of shut-off valve installed.
 - e. Operating instructions and parts lists, as printed by each manufacturer of each type of equipment installed. Refer to "Material" section of the specifications and legend on the drawings.
 - f. List of equipment with names and addresses of local manufacturer representatives.
 - g. "As-built" drawings and controller charts.
2. The above-mentioned equipment shall be turned over to the Owner at the conclusion of the project. Before final acceptance can occur, evidence that the Owner has received material must be shown to the Architect.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Contractor is cautioned to exercise care in handling, loading, unloading, and storing of PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged will be.

1.06 GUARANTEE:

- A. The one (1) year guarantee for the sprinkler irrigation system shall be made in accordance with the General Conditions. A copy of the guarantee form shall be included in the operations and maintenance manual.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Materials for irrigation installation shall be new materials and as specified unless specifically approved in writing by the Owner's representative as equal products. They shall conform to the provisions of the Drawings and Specifications.
1. All materials shall be as noted on irrigation legend and details, unless otherwise noted.
 2. All materials shall be reviewed and approved by Owner's representative.
 3. All materials shall be brass where applicable.
- B. Electrical:
1. High Voltage: All high voltage electrical service required for automatic controller and other equipment noted on Drawing for irrigation system will be provided by others. Irrigation Contractor shall be responsible for final connection.
 2. Low Voltage: Connections between controller and remote control valves shall be made with direct burial AWG-UF, 600 volt wire, insulation thickness 3/64", utilizing low density high molecular weight polyethylene insulation. Splices, where permitted, shall be waterproofed using splices or fusible heat shrinking tubing and housed in a box. Boxes for other irrigation may be utilized for this purpose. Wire sizing shall be a minimum of #14 "UF. 600 volt underground wiring. Common wire is to be white in color, and all others a different color.
- C. Piping:
1. PVC (Solvent Weld):
 - a. Pipe: Manufactured from virgin polyvinyl chloride compound in accordance with ASTM D 1785 or ASTM D 2241, cell classification 12454B, and hydrostatic design stress rating not less than 2,000 P.S.I.
 - b. Fittings (Solvent weld or thread) Standard weight, Schedule 40, side gated, injection molded PVC complying with ASTM D 2466, cell classification 12454B, including threads when required.
 - c. PVC nipples shall be Schedule 80 with machine threads.
 - d. All PVC pipe must be labeled with the following markings:
 - 1) Manufacturer's name.
 - 2) Nominal pipe size.
 - 3) Schedule or class.
 - 4) Pressure rating in A.S.T. (Not required on drip tubing).
 - 5) NSF National Sanitation Foundation) approval (Not required on drip tubing).
 - 6) Date of extrusion.
 - e. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation method prescribed by the manufacturer.

2. Galvanized Pipe and Fittings:
 - a. Pipe shall be galvanized steel, American National Standard Institute (ANSI), Schedule 40 galvanized, mild steel screwed pipe.
 - b. Fittings: Screwed beaded malleable iron, or 125 pound cast iron, flanged.
 - 1) Schedule 80 Socked Weld.
 - 2) Schedule 40 PVC.
 - 3) Marlex Schedule 80 Socked Weld Fittings.
 - c. Unions (2" and Smaller): Ground joint pattern.
 - d. Unions (Larger Than 2"): Flanged type, packed with 1/16" thick fiber gaskets.
 3. Copper Pipe and Copper Fittings: Pipe and fittings shall be provided wherever local codes require its use, as for example under building slabs and attached to parking structure roofs.
- D. Protective Enclosures: backflow devices and other above-ground devices shall be equipped with a vandal resistant protective enclosure, min. 1 ¼" diameter steel tube frame, min. #13 expanded metal panels, single swing with gated end, lockable, powder-coated per owner's color preference.
- E. Controller: shall be a smart controller with rain sensor and hard-wired to Campus central control as shown in legend and plans.
1. Calsene-Cs3000 or approved equal.
- F. Controller Enclosure:
1. StrongBox (VIT Products), with QuickPad, Controller Subassembly, and Rain Switch Enclosure options.
 2. Toro Sentinel Enclosure.
- G. Grounding Rod:
1. Paige 182007 with Paige 1820037P Connection.
- H. Control Wire:
1. Common:
 - a. Paige P7001D 12 Awg White.
 2. Hot:
 - a. Paige P7001D 14 Awg Colored.
- I. Waterproof Wire Connector.
1. Spears Ds-500 Dri-Splice.
- J. Remote Controller:
1. Toro TMR-1 Remote Control System or approved equal.
- K. Remote Site Management System:
1. Toro TriComm System or approved equal.
- L. Flow Sensor:

1. Toro TFS Series.
 2. Rain Bird FS Series.
 3. Calsense Flow Sensor (Brass).
- M. Rain Sensor:
1. Toro TRS Wired Rainsensor.
 2. Hunter Rain-Clik Sensor.
- N. Booster Pump:
1. Barrett Irriboost with variable speed drive and stainless-steel enclosure.
- O. Basket Strainer:
1. Yardney SBX-T Series.
- P. Basket Strainer Enclosure:
1. StrongBox (VIT Products) SBBC-XXSS with QuickPad option.
- Q. Fertilizer Injector:
1. Ez-Flo Ez Series.
- R. Master Valve:
1. Toro 220 (Brass).
 2. Toro P-2205 (Plastic).
- S. Pressure Reducing Valve:
1. Zurn Wilkins 500XL.
- T. Electric Control Valves: Each control zone shall have its own manual shut off valve.
1. Hunter IBV (Brass).
 2. Superior 950 (Brass).
 3. Toro 220 (Brass).
 4. Toro P-220S (Plastic).
 5. Rain Bird P-220 (Brass).
- U. Boxes For Remote Control Valves: boxes shall be rectangular concrete boxes with locking covers.
- V. Quick Coupling Valves: Valves shall be as shown in legend and details.
1. Rain Bird 44NP.
 2. Toro 474-44.
- W. Hose and Swivel Assemblies: Supply 1 set of hose and swivel assemblies for every 5 quick coupling valves.
- X. Air Release Valve:

1. Cla-Val #33-A Series.
- Y. Ball Valves:
1. 2" and smaller.
 - a. Nibco T-585-70 Series.
- Z. Gate Valves:
1. 2" and smaller.
 - a. Nibco T-113 Series.
 2. 2-1/2" and larger.
 - a. Nibco F-619 Series.
 - b. Mueller Resilient Wedge.
- AA. Gate Valve Boxes: Boxes shall be rectangular concrete boxes with locking covers, manufactured by Brooks or Carson or equal, and shall be of size and type as called out on the Drawings and in the details.
- BB. Spray Sprinkler Heads: Heads shall be of the adjustable type, sizes, and designations as shown on Drawings, or equal, and shall be sized, selected, and placed in a manner to achieve complete water coverage of areas to be irrigated.
1. Hunter
 - a. I-20 Series.
 - b. I-40 Series.
 - c. 540 Series.
 2. Rain Bird
 - a. 1800 Series.
 - b. 5000 Series.
 - c. Falcon Series (Stainless-Steel Body).
- CC. Rotor Sprinkler Heads:
1. Toro
 - a. TR70P Series.
 - b. T5 Rapid Set Series Rotor.
 - c. 570Z-Prx-Com-E with precision rotating nozzle.
 2. Rain Bird
 - a. 5000 Series.
 - b. Falcon Series (Stainless-Steel Body).
 3. Hunter
 - a. I-20 Series.
 - b. I-40 Series.
- DD. Artificial Turf Cooling System Heads:

1. Toro TS90TP Series, or approved equal.

EE. Tree Root Watering System:

Rain Bird Root Watering System (RWS).

PART 3 EXECUTION

3.01 WORK PROCEDURES:

- A. Contractor shall follow local building codes, customary practices and as follows:
- B. General: The Contractor shall connect to existing water supply as shown on the Drawings and as necessary to carry out the intent of the Drawings and Specifications. Check location of lines, valves, other underground utilities, etc., and receive approval of Owner's representative before any installation. The Contractor shall check and verify existing water pressure and available gallonage before starting Work and shall inform the Architect if not adequate as designed.
- C. Trenches, Subgrades, and Backfill: Excavate trenches, prepare subgrades and backfill true to line and grade with sufficient room for pipe fittings, testing, and inspection operations. Cut bottom of trench so that pipe barrel rests uniformly on trench bottom. Do not backfill until pipe system has been subjected to a hydrostatic test as specified.
- D. Depth: Depth of coverage for irrigation piping shall be as follows:
 1. Main lines - 18 inches minimum depth.
 2. Lateral lines - 12 inches minimum depth.
 3. Where subslab conflicts, install as deep as possible.
 4. 24 inch depth for all lines under driveways.
- E. Backfill: Backfill trenches after acceptance of Work with suitable approved material, tamping soil around pipe, and thoroughly water settling all trench fills. Trenches under walks and roads shall be backfilled in accordance with General and Special Conditions of the Specifications. Wherever subsidence of trenches occurs, the Contractor shall be responsible for restoring all to final grade.
- F. Control Valves: Locate control valves near walks or to accessible areas; control valves shall never be more than 12" from walks or nearest access as indicated on Drawings and in a manner to make them accessible to manual operations without interference of water spray from heads.
- G. Quick Coupling Valves: Install all quick coupling valves as indicated on Drawings and to conform to the full intent and meaning of the Drawings and the Specifications.
- H. Pipe: All pipe shall be laid true and accurate to grade with full length of pipe section lying solidly on a firm base. If grade or joint of pipe is disturbed after laying, it shall be taken up and relaid.
 1. Clean interior of pipe thoroughly and remove all dirt or foreign matter before lowering pipe into trench and keep clean during operations by plugs or other approved method. The ends of all threaded pipe shall be reamed out full size and with a long taper reamer so as to be partially bell-mouthed and perfectly smooth. All offsets shall be made with fittings. All water lines shall be thoroughly flushed out before the heads are installed.

2. Threads on pipe shall be cut with sharp clean dies to conform to American Standards Association Specifications and so that not more than 2 threads are left exposed on the pipe.
 3. Joints in all screwed metallic and metallic to plastic piping shall be made by applying specified pipe joint compound tape to the threaded end with one-half inch lapping before screwing joints together.
 4. Do not lay pipe in water or mud. Keep ends of pipe securely closed when work is not in operation to prevent water or other matter from entering the lines.
 5. Long runs of PVC pipe shall be slightly snaked in the trench to allow for contraction.
 6. Replace without cost to the Owner any pipe that is found to be defective.
 7. Provide unions and fittings as necessary to make all connections to existing lines and to complete Work as intended on the Drawings.
 8. Install dielectric couplings and flanges as required at the junction of pipes or fittings made of dissimilar metal.
 9. Risers to sprinkler heads shall be Schedule 80 PVC, or as shown in the details, and offset from laterals as indicated on the Drawings.
 10. All sprinkler heads next to walks, paths, parking areas, and any areas where people normally walk shall be the pop-up type. No fixed sprinkler risers shall be installed next to such walks, paths, or parking areas.
 11. Solvent weld joints will be made as follows:
 - a. Good square cuts, clean and free of debris and shavings and moisture.
 - b. Main Line Only: Apply p-70 Weldon or equal. Finish make up of joint using Weldon 711 or equal. Hot glue will not be permitted.
- I. Tests: Test all sprinkler mains after pipe is laid and joint completed by submitting to a pressure test of static pressure in the presence of the Owner's representative. Do not backfill any trench until the Owner's representative has approved the test. Repair any leaks until lines meet test requirements and the Owner's representative's approval. All laterals shall be tested under main pressure for leaks; any leaks shall be repaired. All tests except for the laterals shall be for the duration of 4 hours with a maximum drop of 4 psi allowed.
- J. Flushing of System:
1. After all new sprinkler pipe lines and risers are in place and connected, all necessary diversion Work has been completed, and prior to installation of sprinkler heads, the control valves shall be opened and full head of water used to flush out the system.
 2. Sprinkler heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Architect.
- K. Sprinkler Heads: Install sprinkler heads as directed. Where they adjoin the edges of walks, set turf pop-up heads in 2" from edge and shrub and rotor heads 6" in from edge. Special conditions for installing heads shall be as shown on the Drawings.
1. Space the sprinkler heads as shown on Drawings or as directed and as necessary to gain full water coverage of the sprinkler areas. Adjust heads as necessary, changing sizes and nozzles until Work is approved.
 2. Add sprinkler heads as needed or as directed for full water coverage of all areas without extra cost to the Owner.
 3. Make final adjustments of all sprinkler heads after soil has settled.

- L. Finish Grade: Bring all areas excavated for the installation to a neat and true finish grade to match adjoining areas.
- M. Completion: Leave entire installation in complete working order, free from any and all defects in material, workmanship, or finish, regardless of any discrepancies and/or omissions in Drawings and Specifications.

3.02 TEMPORARY REPAIRS:

- A. Owner reserves the right to make temporary repairs as necessary to keep the sprinkler system equipment in operating condition. The exercise of this right by the Owner shall not relieve the Contractor of his responsibility under the terms of the guarantee as specified herein.

3.03 MAINTENANCE:

- A. The entire sprinkler irrigation system shall be under fully automatic operation for a period of seven days prior to any planting.

3.04 CLEANUP:

- A. Clean-up shall be performed as each portion of Work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage sustained to the Work of others shall be repaired and Work returned to its original condition.

3.05 PROJECT RECORD (AS-BUILT) DRAWINGS

- A. Document field changes from original design and construction documents. Maintain on-site and separate from original construction documents, one complete set of documents labeled "Project Field Documents". Keep documents current. Do not permanently cover work until accurate "as-built" information is recorded.
- B. Record pipe network alterations daily. Record work that is installed differently than shown on construction documents. Record accurate reference dimensions, measured from at least two permanent reference points of each control zone kit assembly, each zone boundary, each air relief valve assembly, each flush point assembly, and other irrigation components enclosed within valve box.
- C. Obtain from General Contractor CADD files prior to construction completion. Duplicate information contained on "Project Field Documents" maintained on-site using technical drafting pen or AutoCAD. Label each sheet "Record Drawing".
- D. Provide "Record Drawings" to Owner's Representative. Completion of Record Drawings is required prior to final construction review at completion of irrigation system installation.

END OF SECTION

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SECTION 32 84 13

DRIP IRRIGATION

PART 1 GENERAL

1.01 SCOPE

- A. This section specification information is for low volume dripline irrigation products including Control Zone Kits, Dripline, compatible fittings, and Low Volume Emission Devices.
- B. Provide labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the drip irrigation system, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein.

1.02 RELATED WORK

- A. Division 00 – Procurement and Contracting Requirements
- B. Division 01 – General Requirements
- C. Division 22 – Plumbing
- D. Division 26 – Electrical
- E. Division 31 – Earthwork
- F. Division 32 – Exterior Improvements
- G. Division 33 - Utilities

1.03 SUBMITTALS

- A. Materials List: Include dripline and low-volume irrigation components, control zone components, shop drawings and other components shown on drawings and installation details or described herein. Quantities of materials need not be included.
- B. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating instructions for equipment shown on materials list.
- C. Shop Drawings: Submit shop drawings called for in installation details. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to installation details as part of shop drawing documentation.

1.04 FLUSHING AND TESTING

- A. Schedule testing with Owner's Representative a minimum of three (3) days in advance of testing.
- B. Provide clean, clear water, pumps, labor, fittings, and equipment necessary to conduct line flushing and testing procedures.

- C. Recommended Dripline and Emitter Lateral Flushing Procedures.
 - 1. Flush the system every two weeks for the first six (6) weeks and check the water that is flushed out for cleanliness. Establish a regular system flushing schedule for the future based on results from the initial six-week flushing schedule.
 - 2. Flush the system completely after any repairs are made and monitor system operation closely under regular system flushing schedule.
 - 3. Check the pressure at the supply and flush headers on a regular basis and compare with the pressure readings taken after installation.
- D. Recommended Dripline and Emitter Lateral Leakage Testing Procedures.
 - 1. Subject installed dripline tubing and emitter lateral piping to water pressure equal to specified operating pressure for ten (10) minutes. Test with control zone components and dripline flush valve components installed.
 - 2. Partially backfill buried pipe and tubing to prevent movement under pressure. Expose couplings, fittings, and valve components.
 - 3. Visually inspect valve assemblies and fittings for leakage and replace defective pipe, fitting, joint, valve, or appurtenance. Repeat test until test segment is free from leaks. Cement or caulking to seal leaks is prohibited.
- E. Recommended Dripline and Emitter Lateral Operational Testing Procedures.
 - 1. Activate each dripline and emitter lateral control zone valve in sequence from controller. Provide either one additional person with radio or use handheld remote to activate remote control valves from controller. Manually activating remote control valve using manual bleed mechanism at remote control valve is not an acceptable method of activation. Owner's Representative will visually observe operation, water application patterns, and leakage.
 - 2. Replace or adjust defective valve, fitting, dripline segment, emitter lateral segment, or appurtenance to correct operational and coverage uniformity deficiencies.
 - 3. Repeat test(s) until each dripline or emitter lateral test segment passes testing procedures. Repeat tests, replace components, and correct deficiencies at no additional cost to Owner and/or Owner's Representative.

1.05 GUARANTEE/WARRANTY AND REPLACEMENT

- A. The purpose of guarantee/warranty is to ensure that Owner receives irrigation materials of prime quality, installed and maintained in thorough and careful manner.
- B. Contractor is responsible for providing guarantee/warranty of irrigation materials, equipment, and workmanship against defects for period of one (1) year from formal written acceptance by Owner's Representative. Fill and repair depressions. Restore landscape, utilities, structures, and site features damaged by settlement of irrigation trenches or excavations. Repair damage to premises caused by defective items. Make repairs within seven (7) days of notification from Owner's Representative.
- C. Replace damaged items with new and identical materials, using methods specified in contract documents or applicable codes. Make replacements at no additional cost to contract price.
- D. Guarantee/warranty applies to originally installed materials and equipment, and replacements made during guarantee/warranty period.

PART 2 MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. For purposes of specification, Rain Bird is shown as the specified manufacturer. Substitutions are allowed on an equivalent basis.

2.02 LATERAL PIPE AND FITTINGS

- A. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with integral belled end suitable for solvent welding.
- B. Use Schedule 40 conforming to dimensions and tolerances established by ASTM Standard D1785; UV radiation resistant.
- C. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.
- D. Use PVC Schedule 80 nipples and PVC Schedule 40 or 80 threaded fittings for threaded pipe connections as specified on the drawings and details.
- E. Threaded joint sealant: Use non-hardening, nontoxic pipe thread sealant formulated for use on threaded connections and approved by pipe fitting or valve manufacturer.

2.03 DRIP IRRIGATION COMPONENTS

A. Control Zone Kits

1. General Information

- a. Control zone kit assemblies for dripline irrigation zones must include control valve, filtration, and pressure regulation components sized to meet the hydraulic demands and flow requirements of the zones that they service.

2. Low Flow Control Zone Kit for dripline zones with flows from 0.2 to 5.0 GPM (0.8 to 18.9 lpm), shall include low flow valve (LFV) and pressure regulating filter (PRF).

a. Low Flow Valve (LFV) component specifications shall include:

- 1) Valve body and bonnet constructed of high impact, weather-resistant plastic, stainless steel and other chemical/UV resistant materials.
- 2) Diaphragm with a double-knife seal, constructed of durable Buna-N rubber with a clog-resistant metering orifice.
- 3) Energy-efficient, low-power encapsulated solenoid with captured plunger and 90 mesh (200 micron) solenoid filter.
- 4) External bleed for manual system flushing during start-up, internal bleed for manual zone activation during maintenance operations.
- 5) Inlet pressure rating: 20 to 120 PSI (1,4 to 8,3 bar)
- 6) Female threaded inlet and outlet connections

- b. Anti-siphon valve configuration shall incorporate atmospheric vacuum breaker with I.A.P.M.O and A.S.S.E. listing approval. Pressure Regulating Filter (PRF) shall combine filtration and pressure regulation in one integrated unit for protection of downstream components of drip irrigation system. PRF component specifications include:
 - 1) Compact “Y” filter body and cap configuration constructed of glass-filled, UV-resistant polypropylene, with 120 PSI (8,3 bar) operating pressure rating.
 - 2) Standard 200 mesh (75 micron) filter screen constructed of durable stainless steel attached to a polypropylene frame. Screen is serviceable for cleaning purposes by unscrewing cap from filter body and removing filter element.
 - 3) Normally-open pressure regulating device with preset outlet pressure of approximately 30 PSI (2,1 bar). Pressure regulating device allows full flow with minimal pressure loss unless inlet pressure is greater than preset level. As inlet pressure increases above preset level, internal spring compresses to reduce downstream pressure.
 - 4) Male threaded 3/4” (19 mm) inlet and outlet connections.
- 3. Medium Flow Control Zone Kit for dripline zones with flows from 3.0 to 15.0 GPM (11.4 to 56.8 lpm).
 - a. Including \ DV or ASVF valve and pressure regulating filter (PRF).
 - b. DV Valve component specifications must include:
 - 1) Valve body and bonnet constructed of high impact, weather-resistant plastic, stainless steel and other chemical/UV resistant materials.
 - 2) Energy-efficient, low-power encapsulated solenoid with captured plunger and 90 mesh (200 micron) solenoid filter.
 - 3) External bleed for manual system flushing during start-up, internal bleed for manual zone activation during maintenance operations.
 - 4) Inlet pressure rating: 20 to 120 PSI (1.4 to 8.3 bar)
 - 5) Female threaded inlet and outlet connections
 - 6) Anti-siphon valve configuration \ includes listed features and incorporates atmospheric vacuum breaker with I.A.P.M.O and A.S.S.E. listing approval.
 - c. Pressure Regulating Filter (PRF) combines filtration and pressure regulation in one integrated unit for protection of downstream components of drip irrigation system. PRF component specifications include:
 - 1) Compact “Y” filter body and cap configuration constructed of glass-filled, UV-resistant polypropylene, with 120 PSI (8,3 bar) operating pressure rating. \
 - 2) Standard 200 mesh (75 micron) filter screen constructed of durable stainless steel attached to a polypropylene frame. Screen is serviceable for cleaning purposes by unscrewing cap from filter body and removing filter element.
 - 3) Normally-open pressure regulating device with preset outlet pressure of approximately 40 PSI (2,8 bar). Pressure regulating device allows full flow with minimal pressure loss unless inlet pressure is greater than preset level. As inlet pressure increases above preset level, internal spring compresses to reduce downstream pressure.

- 4) Male threaded 1" (25 mm) inlet and outlet connections.
4. Medium Flow Commercial Control Zone Kits for dripline zones with flows from 3.0 to 20.0 GPM (11.4 to 75.7 lpm), including PESB valve with PVC ball valve and pressure regulating quick-check basket filter and PGA valve with pressure regulating basket filter.
 - a. PESB valve assembly component specifications must include:
 - 1) 1" (25 mm) PVC full-port ball valve with female threaded inlet and outlet connections
 - 2) PESB valve body and bonnet constructed of durable glass-filled nylon, stainless steel and other chemical/UV resistant materials
 - 3) Diaphragm constructed of a durable Buna-N rubber material reinforced with nylon.
 - 4) One-piece solenoid with captured plunger and 90 mesh (200 micron) solenoid filter.
 - 5) External bleed for manual system flushing during start-up, internal bleed for manual zone activation during maintenance operations.
 - 6) Inlet pressure rating: 20 to 200 PSI (1,4 to 13,8 bar)
 - 7) Female threaded inlet and outlet connections
 - b. PGA valve assembly component specifications must include:
 - 1) PGA valve body and bonnet constructed of durable glass-filled nylon, stainless steel and other chemical/UV resistant materials.
 - 2) Diaphragm constructed of a durable Buna-N rubber material reinforced with nylon.
 - 3) One-piece solenoid with captured plunger and 90 mesh (200 micron) solenoid filter.
 - 4) External bleed for manual system flushing during start-up, internal bleed for manual zone activation during maintenance operations.
 - 5) Inlet pressure rating: 15 to 150 PSI (1,4 to 13,8 bar)
 - 6) Female threaded inlet and outlet connections
 - c. Pressure Regulating Quick Check Basket Filter combines filtration and pressure regulation in one integrated unit for protection of downstream components of drip irrigation system. Pressure regulating basket filter component specifications must include:
 - 1) Basket style body and jar-top cap constructed of heavy-duty glass-filled, UV-resistant polypropylene, with 150 PSI (10,3 bar) operating pressure rating.
 - 2) Indicator incorporated into filter cap that changes color from green to red during operation when the filter element requires cleaning.
 - 3) Standard 200 mesh (75 micron) filter screen constructed of stainless steel attached to propylene frame. Screen is serviceable for cleaning purposes by unscrewing cap from filter body and removing filter element.

- 4) Normally-open in-line pressure regulating device, constructed of durable, UV resistant non-corrosive material able to accommodate an inlet pressure rating of not less than 150 PSI (10,3 bar), with preset outlet pressure of approximately 40 PSI (2,8 bar). Pressure regulating device allows full flow with minimal pressure loss unless inlet pressure is greater than preset level. As inlet pressure increases above preset level, internal spring compresses to reduce downstream pressure.
 - 5) Male threaded 1" (25 mm) inlet and outlet connections.
5. Control Zone Kit for dripline zones with flows from 15.0 to 40.0 GPM (56,8 to 151,4 lpm), including PESB valve and two parallel pressure regulating quick-check basket filters.
- a. PESB valve assembly component specifications must include:
 - 1) PESB valve body and bonnet constructed of durable glass-filled nylon, stainless steel and other chemical/UV resistant materials
 - 2) Diaphragm constructed of a durable rubber material reinforced with nylon
 - 3) One-piece solenoid with captured plunger and 90 mesh (200 micron) solenoid filter
 - 4) External bleed for manual system flushing during start-up, internal bleed for manual zone activation during maintenance operations.
 - 5) Inlet pressure rating: 20 to 200 PSI (1,4 to 13,8 bar)
 - 6) Female threaded inlet and outlet connections
 - b. Pressure Regulating Quick Check Basket Filter combines filtration and pressure regulation in one integrated unit for protection of downstream components of drip irrigation system. Pressure regulating basket filter component specifications must include:
 - 1) Basket style body and jar-top cap constructed of heavy-duty glass-filled, UV-resistant polypropylene, with 150 PSI (10,3 bar) operating pressure rating.
 - 2) Indicator incorporated into filter cap that changes color from green to red during operation when the filter element requires cleaning.
 - 3) Standard 200 mesh (75 micron) filter screen constructed of stainless steel attached to propylene frame. Screen is serviceable for cleaning purposes by unscrewing cap from filter body and removing filter element.
 - 4) Normally-open in-line pressure regulating device, constructed of durable, UV resistant non-corrosive material able to accommodate an inlet pressure rating of not less than 150 PSI (10,3 bar), with preset outlet pressure of approximately 40 PSI (2,8 bar). Pressure regulating device allows full flow with minimal pressure loss unless inlet pressure is greater than preset level. As inlet pressure increases above preset level, internal spring compresses to reduce downstream pressure.
 - 5) Male threaded 1" (25 mm) inlet and outlet connections.

B. Dripline Components

1. General Information
 - a. Provide flexible dual-layered pressure-compensating inline Dripline.
 - b. Provide insert or compression fittings that are compatible with inline emitter tubing as indicated on construction drawings.
2. Rain Bird XFD On-Surface Dripline with pressure-compensating inline emitters.:

- a. Available Rain Bird XFD On-Surface Dripline model numbers for POTABLE water systems; a dual-layered, brown colored dripline tubing with emitter flow rates and spacing as shown:
 - 1) Rain Bird XFD-06-12; 0.6 GPH (2,3 lph) emitters spaced 12" (30,5 cm) on-center.
 - 2) Rain Bird XFD-06-18; 0.6 GPH (2,3 lph) emitters spaced 18" (45,7 cm) on-center.
 - 3) Rain Bird XFD-09-12; 0.9 GPH (3,4 lph) emitters spaced 12" (30,5 cm) on-center.
 - 4) Rain Bird XFD-09-18; 0.9 GPH (3,4 lph) emitters spaced 18" (45,7 cm) on-center.
 - b. Available Rain Bird XFDP On-Surface Dripline model numbers for NON-POTABLE water systems; a dual-layered, purple colored dripline tubing with emitter flow rates and spacing as shown:
 - 1) Rain Bird XFDP-06-12; 0.6 GPH (2,3 lph) emitters spaced 12" (30,5 cm) on-center.
 - 2) Rain Bird XFDP-06-18; 0.6 GPH (2,3 lph) emitters spaced 18" (45,7 cm) on-center.
 - 3) Rain Bird XFDP-09-12; 0.9 GPH (3,4 lph) emitters spaced 12" (30,5 cm) on-center.
 - 4) Rain Bird XFDP-09-18; 0.9 GPH (3,4 lph) emitters spaced 18" (45,7 cm) on-center.
 - c. Required dripline tubing material and performance specifications include:
 - 1) XFD tubing; dual-layered, brown in color, conforming to an outside diameter (O.D.) of 0.634 inches (16 mm) and an inside diameter (I.D.) of 0.536 inches (13,6 mm) and wall thickness of 0.049 inches (1,2 mm)
 - 2) XFDP tubing; dual-layered, purple in color, conforming to an outside diameter (O.D.) of 0.634 inches (16 mm) and an inside diameter (I.D.) of 0.536 inches (13,6 mm) and wall thickness of 0.049 inches (1,2 mm)
 - 3) Factory installed, pressure-compensating, inline emitters welded to the inner circumference of the polyethylene tubing at spacing specified by model number.
 - 4) Inline emitters designed to pressure-compensate by lengthening the emitter's turbulent flow path (Rain Bird patent pending)
 - 5) Consistent flow rate from each installed inline emitter when emitter inlet pressure is supplied between recommended operating range of 8.5 to 60 PSI (0,7 to 4,1 bar)
 - 6) Required filtration for XF Series dripline tubing and emitters is 120 mesh (125 micron)
3. Rain Bird XFCV Dripline with Heavy-Duty Check Valve and pressure-compensating inline emitters.
 - a. Available Rain Bird XFCV Dripline with Heavy Duty-Check Valve model numbers for POTABLE water systems; brown colored dripline tubing with emitter flow rates and spacing as shown:
 - 1) Rain Bird XFCV-06-12; 0.6 GPH (2,3 lph) emitters spaced 12" (30,5 cm) on-center.

- 2) Rain Bird XFCV-06-18; 0.6 GPH (2,3 lph) emitters spaced 18" (45,7 cm) on-center.
 - 3) Rain Bird XFCV-09-12; 0.9 GPH (3,4 lph) emitters spaced 12" (30,5 cm) on-center.
 - 4) Rain Bird XFCV-09-18; 0.9 GPH (3,4 lph) emitters spaced 18" (45,7 cm) on-center.
- b. Required dripline tubing material and performance specifications include:
- 1) XFCV tubing; dual-layered, brown in color, conforming to an outside diameter (O.D.) of 0.634 inches (16 mm) and an inside diameter (I.D.) of 0.536 inches (13,6 mm) and wall thickness of 0.049 inches (1,2 mm)
 - 2) Inline emitter that includes a 3.5psi check-valve to facilitate 8ft of holdback.
 - 3) Factory installed, pressure-compensating, inline emitters welded to the inner circumference of the polyethylene tubing at spacing specified by model number.
 - 4) Inline emitters designed to pressure-compensate by lengthening the emitter's turbulent flow path (Rain Bird patent pending)
 - 5) Consistent flow rate from each installed inline emitter when emitter inlet pressure is supplied between recommended operating range of 8.5 to 60 PSI (0,7 to 4,1 bar)
 - 6) Required filtration for XF Series dripline tubing and emitters is 120 mesh (125 micron)
4. Rain Bird XFS Sub-Surface Copper-Colored Dripline with Copper Shield™ Technology and pressure-compensating inline emitters.
- a. Available Rain Bird XFS Sub-Surface Copper-Colored Dripline model numbers for POTABLE water systems; dual layered, copper colored dripline tubing with emitter flow rates and spacing as shown:
- 1) Rain Bird XFS-06-12; 0.6 GPH (2,3 lph) emitters spaced 12" (30,5 cm) on-center.
 - 2) Rain Bird XFS-06-18; 0.6 GPH (2,3 lph) emitters spaced 18" (45,7 cm) on-center.
 - 3) Rain Bird XFS-09-12; 0.9 GPH (3,4 lph) emitters spaced 12" (30,5 cm) on-center.
 - 4) Rain Bird XFS-09-18; 0.9 GPH (3,4 lph) emitters spaced 18" (45,7 cm) on-center.
- b. Available Rain Bird XFSP Sub-Surface Copper-Colored Dripline model numbers for NON-POTABLE water systems; dual layered purple colored dripline tubing with emitter flow rates and spacing as shown:
- 1) Rain Bird XFSP-06-12; 0.6 GPH (2,3 lph) emitters spaced 12" (30,5 cm) on-center.
 - 2) Rain Bird XFSP-06-18; 0.6 GPH (2,3 lph) emitters spaced 18" (45,7 cm) on-center.
 - 3) Rain Bird XFSP-09-12; 0.9 GPH (3,4 lph) emitters spaced 12" (30,5 cm) on-center.
 - 4) Rain Bird XFSP-09-18; 0.9 GPH (3,4 lph) emitters spaced 18" (45,7 cm) on-center.

- c. Dripline tubing material and performance specifications:
 - 1) XFS Copper-colored, dual layered tubing conforming to an outside diameter (O.D.) of 0.634 inches (16 mm) and an inside diameter (I.D.) of 0.536 inches (13,6 mm) and wall thickness of 0.049 inches (1,2 mm)
 - 2) XFSP tubing; dual layered, purple in color, conforming to an outside diameter (O.D.) of 0.634 inches (16 mm) and an inside diameter (I.D.) of 0.536 inches (13,6 mm) and wall thickness of 0.049 inches (1,2 mm)
 - 3) Factory installed, pressure-compensating, inline emitters welded to the inner circumference of the polyethylene tubing at spacing specified by model number
 - 4) Consistent flow rate from each installed inline emitter when emitter inlet pressure is supplied between recommended operating range of 8.5 to 60 PSI (0,7 to 4,1 bar)
 - 5) Required filtration for XF Series dripline tubing and emitters is 120 mesh (125 micron)
- 5. Rain Bird XF Series Blank Dripline Tubing
 - a. Available model numbers for POTABLE water systems:
 - 1) Rain Bird XFD blank tubing, dual-layered and brown in color.
 - b. Available model numbers for NON-POTABLE water systems:
 - 1) Rain Bird XFDP blank tubing, dual-layered and purple in color.
- 6. Rain Bird Easy Fit Dripline Tubing Compression Fittings
 - a. Available model numbers, designed for compatibility with Rain Bird XF Series Dripline Tubing:
 - 1) Tee: MDCFTEE
 - 2) Coupling: MDCFCOUP
 - 3) Elbow: MDCFEL
 - 4) Adapters:
 - (a) 1/2" (13 mm) Male pipe thread adapter: MDCF50MPT
 - (b) 3/4" (19 mm) Male pipe thread adapter: MDCF75MPT
 - (c) 1/2" (13 mm) Female pipe thread adapter: MDCF50FPT
 - (d) 3/4" (19 mm) Female pipe thread adapter: MDCF75FPT
 - (e) 3/4" (19 mm) Female hose thread adapter: MDCF75FHT
 - 5) Flush Cap end closure for POTABLE system: MDCFPCAP
 - 6) Flush Cap end closure for NON-POTABLE system: MDCFPCAP
 - b. Easy Fit compression fitting material and performance specifications include:
 - 1) Easy Fit directional fittings and flush cap fittings constructed from molded UV-resistant ABS material with Buna-N rubber seal for long-term, leak free connections.
 - 2) Easy Fit adapters constructed from UV-resistant ABS materials for use exclusively with Easy Fit Compression Fittings

- 3) Easy Fit Compression Fittings are intended for use with polyethylene tubing from .630" to .669" (16 mm-17 mm) OD to provide a leak-free compression fit.
 - 4) Maximum pressure loss for the Easy Fit adapters estimated to be 0.1 PSI (0,007 bar) per adapter.
 - 5) Operating pressure range for Easy Fit compression fittings and adapters is 0 to 60 PSI (0 to 4,1 bar)
7. Rain Bird XF Series Dripline Tubing Insert Fittings
- a. Available model numbers, designed for compatibility with Rain Bird XF Series Dripline Tubing:
 - 1) Tee: XFF____TEE insert tee (17 x17 x 17 mm)
 - 2) Coupling: XFF-COUP____insert coupling (17 x 17 mm)
 - 3) Elbow: XFF-ELBOW insert elbow (17 x 17 mm)
 - 4) Cross: XFD-CROSS insert cross (17 x 17 x 17 x 17 mm)
 - 5) Insert Adapters:
 - (a) 1/2" (13 mm) Male pipe thread adapter: XFF-MA-050 [17 mm x 1/2" (13 mm) MPT]
 - (b) 3/4" (19 mm) Male pipe thread adapter: XFF-MA-075 [17 mm x 3/4" (19 mm)MPT]
 - (c) 3/4" (19 mm) Female pipe thread adapter: XFD-FA-075 [17 mm x 3/4" (19 mm)FPT]
 - (d) 1/2" (13 mm) Tee male pipe thread adapter: XFF-TMA-050 [17 mm x 1/2" (13 mm)MPT x 17 mm]
 - (e) 3/4" (19mm) Tee female pipe thread adapter: XFD-TFA-075 [17 mm x 3/4" (19 mm)FPT x 17 mm]
 - b. Insert fitting specifications and features include:
 - 1) Constructed from acetyl plastic.
 - 2) Intended for use with polyethylene tubing with ID of 0.536" (13,6 mm) Operating pressure range is 0 to 50 PSI (0 to 3,5 bar)
8. Rain Bird Air Relief Valves.
- a. Available model numbers, designed for compatibility with Rain Bird XF Series Dripline Tubing:
 - 1) ARV050 Air Relief Valve; includes 1/2" (13 mm) air relief valve.
- C. Rain Bird Point Source Irrigation Emission Devices
1. General Information
 - a. Provide low-volume point-source emission devices to efficiently deliver irrigation water at the plant root zone as indicated on construction drawings.
 2. Rain Bird Single-outlet Xeri-Bug™ Emitters
 - a. Available model numbers with self-piercing barb inlet:
 - 1) XB-05PC (Blue); 0.5 GPH (1,89 lph)
 - 2) XB-10PC (Black); 1.0 GPH (3,79 lph)

- 3) XB-20PC (Red); 2.0 GPH (7,57 lph)
 - b. Available model numbers with 10-32 threaded inlet:
 - 1) XB-05PC-1032 (Blue); 0.5 GPH (1,89 lph)
 - 2) XB-10PC-1032 (Black); 1.0 GPH (3,79 lph)
 - 3) XB-20PC-1032 (Red); 2.0 GPH (7,57 lph)
 - c. Available model numbers with 1/2" (13 mm) threaded inlet:
 - 1) XBT-10 (Black); 1.0 GPH (3,79 lph)
 - 2) XBT-20 (Red); 2.0 GPH (7,57 lph)
 - d. Single-outlet Xeri-Bug Emitter specifications and features include:
 - 1) Available with three inlet options:
 - (a) Self-piercing barb inlet; Emitters with self-piercing barb inlet permit one-step insertion into 1/2" (13 mm) or 3/4" (19 mm) drip tubing when installed with manufacturer's tool.
 - (b) 10-32 threaded inlet; Emitters with 10-32 threaded inlet allow threaded connection into PolyFlex Riser, 1032 Thread Adapter, or 1800 Xeri-Bubbler Adapter
 - (c) 1/2" (13 mm) threaded inlet; Emitters with 1/2" (13 mm) threaded inlet allow threaded connection into 1/2" (13 mm) PVC male adapter.
 - 2) External surfaces constructed from UV resistant acetyl materials.
 - 3) Self-flushing to minimize clogging.
 - 4) Color-coded to identify flow rate.
 - (a) Blue emitter indicates a flow rate of 0.5 GPH (1,89 lph)
 - (b) Black emitter indicates a flow rate of 1.0 GPH (3,79 lph)
 - (c) Red emitter indicates a flow rate of 2.0 GPH (7,57 lph)
 - 5) Pressure-compensating over the pressure range of 15 to 50 PSI (1,0 to 3,5 bar) with consistent flow rate of [0.5 GPH (1,89 lph)] or [1.0 GPH (3,79 lph)] or [2.0 GPH (7,57 lph)] over this pressure range
3. Rain Bird Single-outlet Pressure-Compensating Modules
- a. Available model numbers with self-piercing inlet barb:
 - 1) PC-05: light brown, 5 GPH (18,95 lph)
 - 2) PC-07: violet, 7 GPH (26,53 lph)
 - 3) PC-10: green, 10 GPH (37,90 lph)
 - 4) PC-12: dark brown, 12 GPH (45,48 lph)
 - 5) PC-18: white, 18 GPH (68,22 lph)
 - 6) PC-24: orange, 24 GPH (90,96 lph)
 - b. Available model numbers with 10-32 threaded inlet:
 - 1) PC-05 1032: light brown, 5 GPH (18,95 lph)
 - 2) PC-07 1032: violet, 7 GPH (26,53 lph)
 - 3) PC-10 1032: green, 10 GPH (37,90 lph)

- c. Available model numbers with 1/2" FPT inlet:
 - 1) PCT-05: light brown, 5 GPH (18,95 lph)
 - 2) PCT-07: violet, 7 GPH (26,53 lph)
 - 3) PCT-10: green, 10 GPH (37,90 lph)
- d. Pressure-Compensating Module specifications and features include:
 - 1) Available with three inlet options:
 - (a) Self-piercing barb inlet; Emitters with self-piercing barb inlet permit one-step insertion into 1/2" (13 mm) or 3/4" (19 mm) drip tubing when installed with Rain Bird Xeriman tool.
 - (b) 10-32 threaded inlet; Emitters with 10-32 threaded inlet allow threaded connection into PolyFlex Riser, 1032 Thread Adapter, or 1800 Xeri-Bubbler Adapter
 - (c) 1/2" FPT Threaded inlet allow threaded connection to 1/2" PVC riser.
 - 2) External surfaces constructed from UV resistant acetyl materials.
 - 3) Color-coded to identify flow rate;
 - (a) Tan outlet indicates a flow rate of 5 GPH (18,93 lph)
 - (b) Violet outlet indicates a flow rate of 7 GPH (26,50 lph)
 - (c) Green outlet indicates a flow rate of 10 GPH (37,85 lph)
 - (d) Dark brown outlet indicates a flow rate of 12 GPH (45,42 lph)
 - (e) White outlet indicates a flow rate of 18 GPH (68,13 lph)
 - (f) Orange outlet indicates a flow rate of 24 GPH (90,84 lph)
 - 4) Pressure-compensating over the pressure range of 10 to 50 PSI (0.7 to 3,5 bar) with consistent flow rate of [5 GPH (18,93 lph)] or [7 GPH 26,50 lph]] or [10 GPH (37,85 lph)] or [12 GPH (45,42 lph)] or [18 GPH (68,13 lph)] or [24 GPH (90,84 lph)] over this pressure range.
- 4. Rain Bird PC Diffuser Cap specifications and features include:
 - 1) Available with two color options:
 - (a) PC Diffuser (Black); This Diffuser Cap is to be used for Pressure-Compensating Module zones serviced by a potable water source.
 - (b) PC DIFF-PPL (Purple); This Diffuser Cap is to be used for Pressure-Compensating Module zones serviced by a non-potable water source.
 - (1) Constructed from UV-resistant polyethylene material
 - (2) Capable of snapping onto Rain Bird Pressure-Compensating Modules to create a bubbler effect and prevent wash out
- 5. Rain Bird Multi-outlet Xeri-Bug Emission Devices
 - a. Available model numbers with barb inlet:
 - 1) XB-05-6: Blue, 0.5 GPH (1,89 lph/outlet)
 - 2) XB-10-6:Black, 1.0 GPH (3,79 lph/outlet)
 - 3) XB-20-6:Red, 2.0 GPH (7,57 lph/outlet)
 - b. Available model numbers with 1/2" (13 mm) female threaded inlet:

- 1) XBT-05-6: Blue, 0.5 GPH (1,89 lph/outlet)
 - 2) XBT-10-6:Black, 1.0 GPH (3,79 lph/outlet)
 - 3) XBT-20-6:Red, 2.0 GPH (7,57 lph/outlet)
- c. Multi-outlet Xeri-Bug specifications and features include:
- 1) Available with two inlet options:
 - (a) Barb inlet; Emitters with barb inlet permit insertion into 1/2" (13 mm) or 3/4" (19 mm) drip tubing
 - (b) 1/2" (13 mm) threaded inlet; Emitters with 1/2" (13 mm) threaded inlet allow threaded connection into 1/2" (13 mm) PVC male adapter.
 - 2) Six outlet ports, barbed to retain 1/4" (6,4mm) distribution tubing.
 - 3) External surfaces constructed from UV resistant acetyl materials.
 - 4) Self-flushing to minimize clogging.
 - 5) Color-coded to identify flow rate.
 - (a) Blue emitter indicates a flow rate of 0.5 GPH (1,89 lph) per outlet.
 - (b) Black emitter indicates a flow rate of 1.0 GPH (3,79 lph) per outlet.
 - (c) Red emitter indicates a flow rate of 2.0 GPH (7,57 lph) per outlet.
 - 6) Pressure-compensating over the pressure range of 15 to 50 PSI (1,0 to 3,5 bar) with consistent flow rate of [0.5 GPH (1,89 lph)] or [1.0 GPH (3,79 lph)] or [2.0 GPH (7,57 lph)] GPH over this pressure range
6. Rain Bird 6-outlet Manifold Emission Device
- a. Available model number:
 - 1) EMT-6XERI
 - b. 6-outlet Manifold specifications and features include:
 - 1) 1/2" (13 mm) female threaded inlet.
 - 2) Six free-flowing outlet ports, barbed to retain 1/4" (6,4 mm) distribution tubing and sealed by manufacturer with durable plastic caps removable with pliers during installation.
 - 3) Recommended operating pressure range between 15 to 50 PSI (1,0 to 3,5 bar)
7. Rain Bird Multi-Outlet Xeri-Bird™ 8 Emission Device
- a. Available model numbers:
 - 1) XBD-80: Xeri-Bird™ 8 unit (includes seven removable port plugs) with filter.
 - 2) XBD-81: Xeri-Bird™ 8 unit with eight 1 GPH (3,79 lph) Xeri-Bug (XB-10-PC) emitters factory installed and filter.
 - b. Xeri-Bird™ 8 specifications and features include:
 - 1) 1/2" (13 mm) threaded device inlet with union base nut to allow removal of the Xeri-Bird 8 body from .
 - 2) Eight independent ports, each capable of accepting a Rain Bird Xeri-Bug™ emitter or Rain Bird PC Module for independent flows from 0.5 to 24 GPH (1,89 to 90,96 lph), or a self-piercing barb connector (SPB-025) for unrestricted flow.

- 3) Eight barbed outlet ports mounted on bottom of device capable of securely retaining 1/4" (6,4 mm) distribution tubing.
- 4) 200 mesh (75 micron) filter, easily serviceable from top of unit.
- 5) Capable of being used with retrofit pressure regulator (PRS-050-30) when pressure regulation is required at unit.

D. Low Volume Broadcast Irrigation Emission Devices

1. General Information

- a. Provide low-volume broadcast emission devices to efficiently deliver irrigation water in a short-radius wetting pattern.

2. Rain Bird Xeri-Bubbler™

- a. Available model numbers with 1/4" (6,4 mm) barb inlet:

- 1) SXB-180-025; half-circle, 5 streams
- 2) SXB-360-025; full-circle, 8 streams
- 3) UXB-360-025; full-circle, umbrella

- b. Available model numbers with 10-32 thread inlet:

- 1) SXB-180-1032; half-circle, 5 streams
- 2) SXB-360-1032; full-circle, 8 streams
- 3) UXB-360-1032; full-circle, umbrella

- c. Available model numbers with 5" (12,7 cm) spike inlet:

- 1) SXB-180-SPYK; half-circle, 5 streams
- 2) SXB-360-SPYK; full-circle, 8 streams
- 3) UXB-360-SPYK; full-circle, umbrella

- d. Xeri-Bubbler™ specifications and features include:

- 1) Three inlet connection options:
 - (a) 10-32 self-tapping thread
 - (b) 1/4" (6,4 mm) barb
 - (c) 5" (12,7 cm) spike
- 2) Three flow pattern options:
 - (a) Half-circle with 5 streams
 - (b) Full-circle with 8 streams
 - (c) Full-circle umbrella pattern
- 3) Flow and radius adjustment capability by turning outer cap
- 4) SXB series features flow range of 0 to 13 GPH (0 to 49,2 lph)
- 5) UXB series features flow range of 0 to 35 GPH (0 to 132,5 lph)
- 6) Operating pressure range between 15 to 30 PSI (1,0 to 2,1 bar)

3. Rain Bird Xeri-Pop™ Micro-Spray

- a. Available model numbers:

- 1) XP-400X; 4-inch (101,6 mm) pop-up

- 2) XP-600X; 6-inch (152,4 mm) pop-up
- 3) XP-1200X; 12-inch (304,8 mm) pop-up
- b. Xeri-Pop™ Micro-Spray specifications and features include:
 - 1) 1/4" (6,4 mm) barb inlet located in base of unit for connection to 1/4" (6,4 mm) distribution tubing.
 - 2) Three pop-up height options:
 - (a) 4-inch (10,16 cm) pop-up
 - (b) 6-inch (15,24 cm) pop-up
 - (c) 12-inch (30,5 cm) pop-up
 - 3) Compatible with the following Rain Bird nozzles:
 - (a) Multi-port Series nozzles
 - (b) 5-series MPR plastic nozzles
 - (c) 5-series plastic bubbler nozzle (use in conjunction with Rain Bird PCS-series pressure compensating screen)
 - (d) 8-series MPR plastic nozzles
 - 4) External body construction using UV-resistant ABS material.
 - 5) Self-flushing, pressure-activated wiper seal
 - 6) Operating pressure range between 20 to 50 PSI (1,4 to 3,5 bar). Optimum performance achieved with 40 PSI (2,8 bar) pressure regulator.
4. Rain Bird Xeri-Sprays™
 - a. Available model numbers:
 - 1) XS-090; Quarter-circle, spray pattern
 - 2) XS-180; Half-circle, spray pattern
 - 3) XS-360; Full-circle, stream spray pattern
 - 4) 360 ADJMST; Full-circle spray
 - b. Xeri-Spray™ specifications and features include:
 - 1) 10-32 self-tapping threaded inlet
 - 2) Four flow pattern options:
 - (a) Quarter-circle spray pattern
 - (b) Half-circle spray pattern
 - (c) Full-circle spray pattern
 - (d) Full-circle mister
 - 3) Operating pressure range between 10 to 30 PSI (0,75 to 2,1 bar)
 - 4) Adjustable flow and radius with integral ball valve
 - (a) Flow adjustability between 0 to 31 GPH (0 to 117,3 lph)
 - (b) Radius adjustability for full-circle sprays between 0 to 13.4 feet (0 to 4,1 m)
 - (c) Radius adjustability for part-circle sprays between 0 to 10.6 feet (0 to 3,2 m)

E. Rain Bird Drip Irrigation Accessories

1. 1/4" (6,4 mm) Barb Transfer Fittings
 - a. Available model numbers:
 - 1) XBF1CONN: 1/4" (6,4 mm) Barb Connector
 - 2) XBF2EL: 1/4" (6,4 mm) Barb x Barb Elbow
 - 3) XBFTEE: 1/4" (6,4 mm) Barb x Barb Tee
 - b. 1/4" (6,4 mm) Barb Transfer Fittings specifications and features include:
 - 1) Three fitting configurations:
 - (a) Connector
 - (b) Elbow
 - (c) Tee
 - 2) Designed for connections of Rain Bird XQ 1/4" (6,4 mm) distribution tubing with an ID of 0.17" (4,3 mm)
 - 3) Barbed on one end to permit easy insertion into any 1/2" (13 mm) or 3/4" (19 mm) polyethylene tubing using a Rain Bird Xeriman® tool (XM-TOOL)
 - 4) Constructed from UV resistant acetyl.
 - 5) Operating pressure range between 0 to 50 PSI (0 to 3.5 bar)
2. Rain Bird Diffuser Bug Cap
 - a. Available model numbers:
 - 1) DBC-025 (Black); for potable water source
 - 2) DBC-025-PPL (Purple); for non-potable water source
 - b. Diffuser Bug Cap specifications and features include:
 - 1) Barb inlet designed to fit into 1/4" (6,4 mm) distribution tubing with ID of 0.16" (4 mm)
 - 2) Flanged shield designed to diffuse water to minimize soil erosion at emission point.
 - 3) Constructed from polyethylene material.
 - 4) Operating pressure range between be 0 to 50 PSI (0 to 3,5 bar)

PART 3 EXECUTION

3.01 INSPECTIONS AND REVIEWS

- A. Pre-construction Site Inspection
 - 1. Verify construction site conditions and note irregularities affecting work of this section. Report irregularities in writing to Owner's Representative prior to beginning work. Commencement of work implies acceptance of existing site conditions.
- B. Utility Locates ("Call Before You Dig")
 - 1. Arrange and coordinate Utility Locates with local authorities prior to construction.
 - 2. Repair underground utilities that are damaged during construction. Make repairs at no additional cost to contract price.

3.02 DRIPLINE EXCAVATION, TRENCHING, AND BACKFILL

- A. Excavate and install pipes at minimum cover indicated in drawings or specifications. Excavate trenches at appropriate width for connections and fittings.
- B. Minimum cover for dripline components (distance from top of pipe to finish grade):
 - 1. Buried PVC manifold and supply header pipe to dripline grid layouts: 12" (30,5 cm) to top of pipe.
 - 2. Buried dripline lateral pipe downstream PVC manifold and supply header pipe: 4" (10 cm) to top of pipe.
 - 3. On-grade dripline lateral pipe downstream PVC manifold and supply header pipe: Secure to finish grade with approved tubing stakes. Install and test prior to installation of landscape fabric and mulch.
- C. Backfill only after buried lines have been reviewed, tested, and approved.
- D. Excavated material is generally satisfactory for backfill. Use backfill free from rubbish, vegetable matter, frozen materials, and stones larger than 2" (50 mm) in maximum diameter. Remove material not suitable for backfill. Use backfill free of sharp objects next to pipe.
- E. Dress backfilled areas to original grade. Incorporate excess backfill into existing site grades. Dispose of excess backfill off site.
- F. Contact Owner's Representative for trench depth adjustments where utilities conflict with irrigation trenching and pipe work.

3.03 ASSEMBLING PIPE AND FITTINGS

- A. General:
 - 1. Keep pipe free from dirt and debris. Cut pipe ends square, debur and clean as recommended by pipe manufacturer.
 - 2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.
- B. PVC Pipe and Fittings:
 - 1. Use only strap-type friction wrenches for threaded plastic pipes.

2. PVC Solvent Weld Pipe and Fittings:
 - a. Use appropriate primer and solvent cement. Join pipe in manner recommended by pipe and fitting manufacturers and in accordance with accepted industry practices.
 - b. Cure for thirty (30) minutes before handling and twenty-four (24) hours before pressurizing or installing with vibratory plow.
 - c. Snake pipe from side to side within trench.
3. PVC Threaded Connections:
 - a. Use only factory-formed threads. Field-cut threads are not permitted.
 - b. Apply thread sealant in manner recommended by component, pipe, and sealant manufacturers and in accordance with accepted industry practices.

C. Dripline Tubing and Fittings:

1. Use only Rain Bird XF-Series Insert Fittings or Rain Bird Easy Fit Compression Fittings for Rain Bird XF-Series dripline tubing connections or transitions as recommended by the Manufacturer's representative for the specific site and system conditions.
2. Dripline Insert Fittings:
 - a. Install dripline tubing and fittings in manner recommended by manufacturer and in accordance with accepted industry practices.
3. Dripline Compression Fittings:
 - a. Install dripline tubing and fittings in manner recommended by manufacturer and in accordance with accepted industry practices.

3.04 INSTALLATION OF DRIPLINE IRRIGATION COMPONENTS

A. Control Zone Kit Assembly:

1. Flush mainline pipe before installing Control Zone Kit assembly.
2. Locate where shown on drawings. Connect control wires to remote control valve wires using specified wire connectors and waterproof sealant. Provide connectors and sealant per manufacturer's recommendations.
3. Install a maximum of four (4) Low Flow or Medium Flow Control Zone Kits per standard rectangular valve box. Install a maximum of one (1) Medium Flow Commercial Control Zone Kits per standard rectangular valve box. Install a maximum of one High Flow Commercial Control Zone Kits per jumbo rectangular valve box.
 - a. Locate valve boxes at least 12" (30,5 cm) from, and align with, nearby walls or edges of paved areas.
 - b. Group Control Zone Kit assemblies together where practical. Align grouped valve boxes in uniform patterns. Allow at least 12" (30,5 cm) between valve boxes.
 - c. Brand controller letter and station numbers on valve box lid in 2" (50 mm) high letters.

B. Lateral Piping and Dripline Tubing:

1. Install lateral piping and dripline tubing at locations and in grid patterns as indicated on drawings and installation details, and in strict accordance with manufacturer recommendations.
2. Thoroughly flush PVC lateral piping, supply headers, and dripline tubing immediately upon installation.

- C. Air Relief Valve Kit Assembly: Install at all high points in dripline tubing grid as shown and directed on drawings and installation details.
- D. Flush Point Assembly: Install flush header or at ends of each dripline zone segment as shown and directed on drawings and installation details. Install at least 12-inches from and align with adjacent walls or edges of paved areas.

3.05 PROJECT RECORD (AS-BUILT) DRAWINGS

- A. Document field changes from original design and construction documents. Maintain on-site and separate from original construction documents, one complete set of documents labeled "Project Field Documents". Keep documents current. Do not permanently cover work until accurate "as-built" information is recorded.
- B. Record pipe network alterations daily. Record work that is installed differently than shown on construction documents. Record accurate reference dimensions, measured from at least two permanent reference points of each control zone kit assembly, each dripline zone boundary, each air relief valve assembly, each flush point assembly, and other dripline irrigation components enclosed within valve box.
- C. Obtain from General Contractor CADD files prior to construction completion. Duplicate information contained on "Project Field Documents" maintained on-site using technical drafting pen or AutoCAD. Label each sheet "Record Drawing".
- D. Provide "Record Drawings" to Owner's Representative. Completion of Record Drawings is required prior to final construction review at completion of irrigation system installation.

3.06 WINTERIZATION AND SPRING START-UP

- A. Winterize irrigation system in fall following completion, or partial completion, of irrigation system construction. Start-up irrigation system in spring following completion, or partial completion, of irrigation system construction. Repair any damage caused in improper winterization at no additional cost to Owner. Coordinate winterization and start-up with landscape maintenance personnel.

3.07 MAINTENANCE

- A. Maintain irrigation system for duration of 30 calendar days from formal written acceptance by Owner's Representative. Make periodic examinations and adjustments to irrigation system components in order to achieve the most efficient and uniform application of water.
- B. Following completion of Contractor's maintenance period, Owner will be responsible for maintaining system in working order during remainder of guarantee/warranty period, for performing necessary minor maintenance, for protecting against vandalism, and for preventing damage after landscape maintenance operation.

3.08 CLEANUP

- A. Remove from site machinery, tools, excess materials, and rubbish upon completion of work.

END OF SECTION

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SECTION 32 90 00

PLANTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Division 1 applies to this Section. Provide all labor, materials, appliances, tools, equipment, facilities, transportation, and services necessary for and incidental to performing all operations in connection with the installation of the Work of this Section, complete as shown on the Drawings and/or specified herein. Work In This Section: Principal items include:

1. Examine all other Sections for Work related to those other Sections and required to be included in this Section.
2. Fine grading in landscaping areas.
3. Landscaping.
4. Rodent and vermin control.
5. Soil Testing and Soil Preparation
6. Plants and Planting
7. Staking
8. Herbicide
9. Watering and maintenance

B. Related Work Not In This Section:

1. Section 32 01 30 – Operation and Maintenance of Site Improvements
2. Section 32 01 90.33 – Tree and Shrub Preservation
3. Section 32 84 00 – Planting Irrigation
4. Section 32 84 13 – Drip Irrigation

1.02 SUBMITTALS

A. Refer to Division 1 for procedures.

B. Materials list: Submit complete material list prior to performing any work. Material list shall include manufacturer, model number, and description of all materials and equipment to be used. The Contractor shall also furnish the articles, equipment, materials, or processes specified by name in Drawings and Specifications. For Tree Submittals, provide photo image, height, canopy, width, and caliper at 4' height. A nursery worker shall stand next to the tree in the image for a sense of scale. For Shrub, Groundcover and Vine Submittals, provide photo image, height, and width of the entire plant. No substitutes will be allowed without prior written acceptance. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense. All cut sheets, nursery images of trees and samples of materials shall be submitted 3 weeks prior to installation

C. Manufacturer's Product Specification Cut Sheets/Data:

1. Provide 6 copies for all materials.
 2. Submit manufacturer's standard printed product data for all items, referenced to article number in this specification for which each item is being submitted.
 3. Submit manufacturer's printed installation instruction and methods.
 4. Material Safety Data Sheets (MSDS): For all products used.
- D. Required Manufacturer's Product Specification Cut Sheets /Physical Samples: Delivery may begin upon approval of Cut Sheets/Samples or as directed by Owner's Representative. Submit Samples in the form of Cut Sheets and Physical samples as required by the Landscape Architect or Owner's Representative and store on the site until furnishing of material is complete. Samples and Cut Sheets required are listed below:
1. Irrigation Equipment (see Section 32 84 00 and 32 84 13)
 2. Submit 'bagged' samples of each of the following, (2) samples of each, accompanied by (6) copies of the manufacturer's specification cut sheets:
 - a. Physical Samples of Bark Mulch
 - b. Decomposed Granite/Stabilizer
 - c. Decorative Rock/Pea Gravel
 - d. Planting Mix, and Soil Amendments. NOTE: Approved samples of each to remain on site until furnishing of materials is complete. Delivery may begin upon approval of all submittals or as directed by Owner's Representative.
 3. Cut Sheets for Tree Root Control Barriers and Aluminum Edging
 4. Cut Sheets for Tree Stakes/Weed Whip Guards
 5. There shall be at least one (1) photograph of each species of tree, shrub, vine and ground cover to be planted. All photographs shall be taken with a person/or a scale in each photo next to the plant. Include with the photographs of all trees a notation of caliper, canopy width and height of each species of tree. If there are multiple boxes or gallon sizes of the same plant, include separate information for each container sized tree.
 6. Fertilizer Analysis: also provide labels of each fertilizer used and the quantities used in each application.
 7. Soil Amendment Analysis
 8. Analysis of Imported Topsoils and Sand
 9. Cut Sheets of Herbicides, Pesticides and Fungicides: Furnish manufacturer's certification by the USDA, description of ingredients, and recommendations for usage and application rates for each material to be used and dates of application 10.Cut Sheets shall be provided for all other products noted in Part 2, 2.01 Soil Additives, Fertilizers, and Herbicides and 2.02 Staking Material.
- E. Certificates: The Contractor shall submit, at time of delivery, to the Inspector of Record (IOR), delivery receipts or tickets of all amendments and soil additives, reflection actual quantities and types of materials delivered to the project site. Delivery receipts or tickets shall include the name of the project and the date of the actual delivery. Four (4) copies of all receipts / tickets shall be forwarded to the Architect, by the Contractor. Approval of types and quantities by the IOR and Architect are required prior to working in or spreading any amendments or soil additives.

- F. Prior to being placed on maintenance, refer to Section 3.06 "Inspection, Start of Maintenance" - the Contractor shall submit a schedule of all activities planned during the maintenance period. This shall be accepted by the Grounds Supervisor prior to the start of the maintenance period. All schedule changes shall be documented and accepted by the Grounds Supervisor.
- G. Prior to the date of the final walk-through, the Contractor shall acquire from the Grounds Supervisor approved reproducible prints and shall produce the final record from the job record set of all changes made to all plans during construction, label said prints, "As-Builts" and deliver to the Grounds Supervisor and as required by any Local Agency. Prior to the date of final inspection, the Contractor shall deliver to the Grounds Supervisor the "Landscape and Irrigation Guarantee" as required. Said Guarantee shall be on the Contractor's letterhead and dated the scheduled final acceptance date.
- H. All turnover items noted in other specification sections shall be delivered prior to the final walk-through.
- I. Supply a monthly record of all herbicides, insecticides, fertilizers, and disease control chemicals with rates and amounts used noted.

1.03 PROTECTION OF WORK

- A. The Contractor shall be responsible for protection of all adjacent finished surfaces and materials, both interior and exterior, while performing all landscape and irrigation operations, including maintenance. These finishes and materials shall be cleaned and returned to as-new condition when work is completed.

1.04 GUARANTEES AND REPLACEMENTS

- A. Refer to Division 1 for more information.
- B. Shrubs: Guarantee shrubs from the time of installation to the end date of the 90-day Maintenance Period.
- C. Trees: Guarantee all trees to live in a healthy condition for (1) one year from the end date of the Maintenance Period. Dead or unhealthy trees shall be replaced within 10 days after notification of Contractor by the Owner's Representative or the Architect.
- D. Dead and Non-Vigorous Plants: As soon as the weather permits, replace all dead plants and all plants not in a vigorous condition as noted at the end of the Maintenance Period.
- E. Replacements: Plants used for replacement shall be the same kind and size as specified on the Planting Plan. They shall be furnished, planted, and fertilized as specified at no additional cost to the Owner. Replacement plants shall be maintained for a period equal to the original maintenance period. They shall be in excellent condition following the replacement and maintenance.
- F. Provide Certificate of Compliance from authority having jurisdiction indicating approval of plants, fertilizer, and herbicide mixture. Plant Materials: Described by ASTM Z60.1; free of disease or hazardous insects.

PART 2 PRODUCTS.

2.01 ADDITIVES, FERTILIZERS, LANDSCAPE MATERIALS, AND HERBICIDES

- A. Mulch : "Walk On-Chips" as supplied by EarthWorks Soil Amendments Inc., (951)782-0260, or equal approved by the Owner's Representative. The mulch shall consist of fibrous, woody bark mixture of varied particle size.
- B. Prepared Planting Mix for Backfill in all Planting Pits Except Raised Planters: Materials and amounts specified here are anticipated. This amendment is for bidding purposes and shall be superseded by recommendation of soil test/analysis report. Mix shall be the following materials thoroughly mixed:
 - 1. By volume: 30% GroMulch and 70% excavated soil
 - 2. Plus 2 lb. 12_12_12 commercial fertilizer per cubic yard of mix.
 - 3. Plus: 3 lb. Agricultural grade gypsum per cubic yard of mix
 - 4. Plus: 2 lb. Iron sulfate per cubic yard of mix
- C. Ammonium Sulfate: Shall be standard brand (NH₄)₂SO₄.
- D. Urea Formaldehyde: 35_0_0 shall be standard brand, as approved by the Architect.
- E. Iron Sulfate: Shall be standard brand 20% Fe.
- F. Vitamin B1 Root Hormone: Hormone shall be Superthrive, Hormex, or equal approved by the Architect.
- G. Nitrolized Fir bark Fines: Fines shall be "Forest Humus" as sold by Kellogg Company, or equal approved by the Architect.
- H. Commercial Fertilizer: Fertilizer shall be 12_12_12, standard commercial brand as approved by the Architect. Nitrogen for this mix shall be derived from 2% ammoniac, 5% urea, and 14% urea formaldehyde.
- I. Gro Mulch: Mulch shall be manufactured by the Kellogg Co.
- J. Herbicide: Herbicide shall be Roundup or equal approved by the Architect.
- K. Fertilizer Tablets: Agriform per manufacturer's recommendations.
- L. Agricultural Gypsum: Gypsum shall be agricultural calcium sulfate CaSO₄ approved by Landscape Architect. This shall only be used in clay or adobe soils.
- M. Mycorrhizal Fungal Inoculant: Plant and Tree Saver Transplant manufactured by Plant Health CareInc. or equal.
- N. Soil Sulfur: Agricultural grade sulfur containing a minimum of 99% sulfur (expressed as elemental).

2.02 STAKING MATERIAL:

- A. Stakes: Stakes for larger plant material shall be 2" diameter x 10'-0" long lodge pole stakes, actual dimension.

- B. Ties: Ties shall be V.I.T. Cinch Ties, Model #CT32 For 24" box trees.
- C. Tree Trunk Guards: Guards shall be Arbor Guard by Deep Root, (714) 898-0563, or equal approved by the Architect and shall be installed on the trunks of all trees in lawn areas.
- D. Root Control Barrier: All 48" box, 36" box, 24" box and 15-gallon trees planted within 6' of any hardscape areas (sidewalks, walls, concrete drainage swales, curbs, driveways, swales, or any other structure) shall include root barriers, root barriers shall extend 5' on either side of the trunk for a total length of 10'. Root barriers are as follows:
 - 1. 36" box trees, 24" box trees, and 15-gallon trees - Model # UB 18-2 available from DeepRoot, (800) 766-8835
 - 2. 48" box trees - Model # UB 24-2 available from DeepRoot, (800) 766-8835

2.03 STEEL EDGING

- 1. Steel edging shall be 1/4" x 5", black color, with 15" steel stake.
 - a. Manufacturer: Sure-Loc. (800) 787-3562.
 - b. Or approved equal.

2.04 JUTE MESH

- A. Shall be Anti-Wash / Geo Jute by Pacific Soil Stabilization, (805) 925-7737

2.05 PLANT MATERIALS

- A. Quality and Size:
 - 1. The quality and size of all plants shall be No. 1 grade. They shall be fresh, vigorous, of normal growth, free of disease, insects, insect eggs and larvae, with strong root systems.
 - 2. Sizes of plants shall be as stated on the planting plan. No root bound or undersized materials shall be allowed.
 - 3. Protect and maintain plant material in a healthy and vigorous condition until planted.
 - 4. Do not install plant material when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
 - 5. Do not place plants in containers or asphalt paving when outdoor temperature exceeds 100 degrees F. for a period exceeding 16 hours.
 - 6. Trees 36" box size or larger shall be tagged at the nursery within 250 miles of the project site.
- B. Pruning: Pruning shall not be done prior to delivery except by special approval of the Architect.
 - 1. Tree Trimmer Qualifications: Company specializing in pruning trees with proof of ISA Arborist Certification and ISA Tree Worker Certification.
 - 2. Tree Pruning: ISA - Pruning Standards for Shade Trees.
- C. Inspection: Inspection of plant materials required by City, State, or Federal authorities shall be the responsibility of the Contractor, and he shall obtain permits or certificates prior to delivery of plants to site.
- D. Plant Marking: Each plant shall be clearly marked with a waterproof tag as to its botanical name as required by California State Agricultural Laws.

- E. Plant reviews: Landscape Architect shall at any time during the tagging, delivery or planting process reject any unhealthy, damaged or dead tree.
- F. Deliver, store, protect and handle products to site under provisions of Section 01600 - Materials and Equipment.

2.06 IMPORTED TOPSOIL

- A. Import Top Soil: Import top soil shall be classified as sandy loam, and must conform to the following:
 - 1. Particle size

	<u>Class Particle Size Range</u>	<u>Maximum %</u>	<u>Minimum %</u>
a.	Silt plus Clay (<0.05mm)	50	15
b.	Coarse Sand (0.5 - 2.0mm)	15	0
c.	Gravel (2.0-13mm)	15	0
d.	Rock (1/2"-1")	5% by volume with none > 1"	
 - 2. Chemistry
 - a. Salinity: Saturation Extract Conductivity (ECe) - less than 3.0 sD/m @ 25° C
 - b. Sodium: Sodium Absorption Ratio (SAR) - less than 6.0
 - c. Boron: Saturation Extract Concentration - Less than 1.0 ppm
 - d. Reaction: pH of Saturated Paste - 5.5-7.8 without high lime content
 - 3. Soil shall contain enough available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.
- B. To ensure conformance, samples of the import soil shall be submitted to an approved laboratory for analysis prior to and following backfilling.
- C. Obtain imported topsoil from approved local sources.
- D. Class A topsoil: good class A topsoil should be used as in the following definition. The soil must have a good structure. If necessary, the soil can be conditioned to help improve the physical soil properties.
 - 1. Topsoil shall be free of roots. Clods and stones larger than 1-inch in the greatest dimension, pockets of coarse sand, noxious weeds such as nut grass roots and nodules, sticks, brush and other litter. It shall not be infested with nematodes or other undesirable insects or plant disease organisms.
 - 2. Topsoil shall be friable and have sufficient structure in order to give good tilth and aeration to the soil. Total pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent by weight.
 - 3. Gradation limits - Soil shall be a sandy loam, loam, or clay loam. The definition of soil texture shall be per the USDA classification scheme.

- E. Quality controls: All topsoils to be imported for the planting areas shall receive an "Agricultural Suitability Analysis" of soils before being placed in the planting areas. Soil shall be tested from the source site. There shall be 1 (one) test from each source site. After delivery to site the soil shall again receive 1 (one) soil test before final placement. These tests are to be collected at the site, by a local soil testing laboratory:
1. Sources:
 - a. Soil and Plant Laboratory, (714) 282-8777
 - b. Wallace Laboratories, (310) 615-0116
 - c. Or approved equal.
- F. Tests shall be submitted to the Architect for approval before placing soils. Tests shall include the following:
1. Must include pH measurement in the Saturation Extract, Electro conductivity of the saturation extract and Sodium Adsorption Ratio of the saturation extract. The approved procedures are the following:
 - a. PH: Method 21
 - b. Saturation Extract: Method 2
 - c. Sodium Adsorption Ratio: Method 20b
 - d. Methods of the United States Salinity Laboratory as published in the Agricultural Handbook Number 60 entitled "Diagnosis and Improvement of Saline and Alkali Soils".
 2. The following nutrients and elements must be determined with an approved extraction method. Interpretation data must be given citing concentrations, which are considered to be low, medium and high: boron, calcium, copper, iron, magnesium, manganese, molybdenum, phosphorus, potassium, sodium, sulfur, and zinc. The approved methods are those cited by the Council on Soil Testing and Plant Analysis and those methods currently used by soil scientists and agronomists and published in Communications in Soil Science and Plant Analysis, Soil Science and Soil Science Society of America Journal. Approved methods are Mehlich Number 3, Bray P1, Bray P2, Olsen P, DTPA, ammonium acetate, ammonium bicarbonate-DTPA, and hot water extract for boron.
 3. The saturated extract must be analyzed for calcium, magnesium, sodium, boron, chloride, nitrate, and sulfate.
 4. The following trace metals must be measured by the DTPA extract: Aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, nickel, selenium, silver, strontium, tin and vanadium.
 5. The presence of calcium carbonate and/or magnesium carbonate must be determined by commonly used methods.
 6. Soil Texture and Organic Matter content may be estimated or determined by commonly used methods.
 7. Interpretation of nutritional deficiencies or excesses and potential toxicities must be given.
 8. If required, determine the following by methods approved by the American Society of Agronomy as published in the Methods of Soil Analysis, methods of the United States Salinity Laboratory as published in the Agricultural Handbook Number 60 entitled "Diagnosis and Improvement of Saline and Alkali Soils," and bulk density of clods by the method published in Soil Science, vol 155, 325-330 (1993):
 - a. Exchangeable Ammonium cation

- b. Base Saturation
 - c. Cation Exchange Capacity
 - d. Carbonates Determination
 - e. Soil Bulk Density (Compaction)
 - f. Sand, Silt and Clay determination.
 - g. Water Infiltration Rate
 - h. Elemental determinations to be made according to methods approved by the EPA or by the American Society of Agronomy.
- G. Possible sources of class A topsoil:
1. Excavations or grading of native topsoil from undeveloped areas.
 2. Excavations or grading of topsoil from previously landscaped or formed areas.
 3. Excavations or grading of topsoil from previously non-landscaped or non-farmed areas if the soil is thoroughly evaluated for potential toxic materials.
 4. Soil supply companies supplying natural topsoil without excessive amending.
 5. Manufacturing of topsoil with less desirable soil as long as the soil has matured and developed the characteristics of class topsoil.
- H. Contractor Responsibilities.
1. Provide inspections, tests and similar quality control services as specified below. The Contractor will pay cost for these services.
 2. Employ and pay an independent agency to perform specified quality control services.
 3. Owner will engage and pay for services of an independent agency to perform inspections and tests, which are not required by the specification.
 4. Retest where results of required inspections, tests or similar services prove unsatisfactory workmanship and materials and do not indicate compliance with specifications regardless of whether the tests and services where not the responsibility of the Contractor will be paid by the Contractor.
- I. Owner Responsibility: Owner will provide and pay for inspections, tests and similar quality control services not specified.
- J. Duties of Testing Agency.
1. Retest where results of required inspections, tests or similar services prove unsatisfactory workmanship and materials and do not indicate compliance with specifications regardless of whether the tests and services where not the responsibility of the Contractor will be paid by the Contractor.
 2. An independent testing agency engaged to perform inspections, sampling and testing of materials shall cooperate with Architect and Contractor in performance of its duties and shall provide qualified personnel to perform required inspections and tests.
 3. The Agency shall notify Architect, owner and Contractor promptly of irregularities or deficiencies observed in the work or materials during performance of its services.
 4. Agency is not authorized to release, revoke, alter or enlarge requirements of specifications or approves or accepts any portion of work or materials.
 5. Agency shall not perform any duties of Contractor.

K. Submittals

1. Independent testing agency shall submit written report of each inspection, test or similar service to Architect and owner unless Contractor is responsible for service. If Contractor is responsible for service, submit written report of each inspection, test or similar service through Contractor.
2. Each source of topsoil shall be tested with representative submittal samples and at various depths. Soil shall be tested from the source site. There shall be a 1 (one) test from each source site. After delivery to site the soil shall again receive 1 (one) soil test before final placement. The owner reserves the right to test delivered materials at owner's expense. If any delivered material fails to meet the specifications, the material will be promptly removed from the site at the Contractor's expense. The Contractor shall pay for the testing of any materials not meeting specifications.

2.07 DECOMPOSED GRANITE MATERIALS

A. Decomposed Granite: Screen evenly and grade from 3/32" max to 0".

1. Sources:
 - a. Gail Materials, (951) 667-6106.
 - b. Southwest Boulder and Stone, (714) 882-1010.
 - c. Or approved equal.

B. Stabilized Binder

1. Patented, non-toxic, organic binder that is a colorless and odorless concentrated powder that binds decomposed granite.

2.08 EXCESS DECOMPOSED GRANITE MATERIALS

- A. Provide owner's authorized rep. with the following excess materials for use in future decomposed granite repair: One (1) 40 to 50 lb. Bags of the aggregate paving blended with proper amount of Stabilizer.

PART 3 EXECUTION

3.01 FINE GRADING

- A. Where any portion of irrigation system is installed after grading and fertilizing has been performed, refill and re-fertilize upper portion of backfill as specified herein.
- B. Fine Grading: Upon completion of rough grading, perform required fine grading of planted areas.
 1. Before and during preliminary fine grading, dig out and remove all weeds and grasses. Dispose of off-site at Contractor's expense.
 2. Remove all rocks larger than one half (1/2) inch in the upper 8" of soils.
 3. Do not work the soil when moisture content is such that excessive compaction will occur, nor when soil is so dry that clods will not break readily.
 4. Apply water, if necessary, to provide ideal density for cross-tilling and for planting.
 5. Grade to anticipate or match the certified finished grades and swales.
 - a. Remove or redistribute excess soil before the application of fertilizer and mulch.

- b. Where soil is to be replaced by plants and/or mulch, make allowance to prevent efficiency in the depth of mulch when final grading is completed.
 - c. Excess soil generated from the planting holes and not used as backfill or in establishing the final grades shall be removed from the site.
- C. Grades and Elevations: When weed abatement, soil preparation and amending is completed, and the soil has dried to be readily worked, fine grade planting areas to elevations shown on Contract Drawings.
- 1. Where grades are not otherwise indicated, provide uniform levels or slopes between points where elevations are given.
 - 2. Make minor adjustments of grade where so requested by the Owner's Representative.
 - 3. Provide finished grades which are even, uniform and without abrupt change of surface.
 - 4. Slope soil areas away from structures to allow natural runoff of water, regrade swale surfaces as required for a minimum 2% run-off, or as indicated on plan. Grade low spots and swales when soil is at optimum moisture content for working.
 - 5. Provide final finished soil grades in planter areas 2 inches below paving and curbs, or as shown on the Contract Drawings. Add mulch on top of soil.
 - 6. Compact all soil to final grades: minimum 80%, maximum 85%, unless otherwise required by soils report or for structural reasons.

3.02 SOIL TESTING, CONDITIONING, FERTILIZING, AND WEED ABATEMENT

- A. Soil Testing: Soils test on site shall be conducted twice:
- 1. After rough grading is complete
 - 2. Before planting commences, but after irrigation installment and soil amendments have been applied.
- B. Tests are to be collected at the site, and analysis and recommendations are to be made by a soil testing and analysis laboratory:
- 1. Sources:
 - a. Soil and Plant Laboratory, (714) 282-8777
 - b. Wallace Laboratories, (310) 615-0116
 - c. Or approved equal.
- C. The Contractor will pay for cost for these services. Copies of tests shall be submitted to the Architect. Contractor shall allow two weeks for each round of soil testing to take place.
- D. Weed Abatement: Determine that rodents and vermin are not present. If rodents and vermin are present control shall be undertaken by a licensed pest control applicator. Weed abatement shall be two grow-kill cycles. Anticipate at least 8 weeks for weed abatement. Contractor shall coordinate the scheduling of any spraying of herbicide to occur on a Friday afternoon or school holiday and shall notify the District one (1) week prior to applications in order for them to post notice. The irrigation system needs to be fully operational and be functioning prior to and during the weed and kill operation. Keep soils moist for 3 weeks. Spray all areas to receive lawn, shrubs or ground cover with herbicide. Keep soils moist for five weeks. Again spray all areas to receive lawn, shrubs or ground cover with herbicide. Follow the manufacturer's recommendations.
- E. After weed abatement, remove and dispose of all dead weeds, including roots.

- F. For existing turf areas to be removed, remove all turf, weeds and roots plus 1" of soil below.
- G. Soil Amendments for planting areas: Do not spread amendments until approval of delivered materials has been received from the IOR and Architect. Materials and amounts specified here are anticipated. This amendment is for bidding purposes and shall be superseded by recommendation of soil test/analysis report.
- H. Tilling: All planting areas in that are 90% soil compaction or above shall be cross-ripped 12" on center to a maximum depth of 10" below grade and follow with rototillage to reduce soil clods to a maximum diameter of 1 -inch in the top 8 inches. Remove stones and foreign matter over one half (1/2) inch in diameter from upper 8" of soil. Planting areas too small for power equipment shall be hand dug and tilled to a depth of 10" below grade. (All tilling shall be completed prior to adding conditioners and fertilizers, unless occupied by existing trees that remain in place) . Any part of the irrigation system, including heads, damaged during tilling shall be replaced with new equipment.
- I. Planting Areas: The following amendments are anticipated. Exact mix and quantities shall be per the recommendations from soil testing results. All planting areas shall receive the following:
 - 1. Gro-Mulch: 3 cubic yards per 1,000 square feet thoroughly mixed into the top 6" of soil for lawn, and 5 cubic yards per 1,000 square feet mixed into top 10" for shrubs and ground cover.
 - 2. Gypsum: 40 lbs./1,000 square feet thoroughly mixed into the top 6" of soil.
 - 3. Commercial fertilizer: 20 lbs./1,000 square feet thoroughly mixed into the top 6" of soil.
- J. Jute Mesh or Matting: Begin at the top of the slope by anchoring the jute mesh in a 6" by 6" wide trench with a 6" steel staple every 12". Backfill and compact the trench after stapling. Roll the blankets down the slope in the direction of the water flow. The edges of parallel rolls of jute mesh must be stapled with approximately a 2" overlap. When the pieces must be spliced down the slope, place the epics end over end (shingle style) with approximately 6" overlap. Staple through overlapped area approximately 12" apart. Also, put 1 staple per square yard all along the roll. Jute mesh is to be installed on all slopes 2-1/2:1 and greater. Repair and stabilize all jute mesh installation that is disturbed during planting installation.

3.03 PLANTING

- A. General:
 - 1. Verify that soils test has been conducted to confirm that amendments have been properly installed prior to commencing planting. Verify that any heads or any parts of the irrigation system damaged by tilling has been repaired, and complete system is operational.
 - 2. Plant all materials as soon as site is available and weather conditions are suitable.
 - 3. Do not plant when weather conditions are unfavorable to good work.
- B. Tree and Large Shrub Planting:
 - 1. Stake plant locations and get approval before excavating pits, making necessary adjustments as directed. Excavate all one gallon and larger plant pits to dimensions shown below.
 - 2. Excavate pits for all plants as shown on the planting details. Tree pits shall be of such a depth that after planting and settling, the crown of the plant shall be at or slightly above its original line of grade and the ball shall sit on compacted soil. The following are minimum sizes for shrub and tree pits:
 - a. 1-gallon plants: 12" diameter hole, depth per detail.

- b. 5-gallon plants: 24" diameter hole, depth per detail.
 - c. 15-gallon plants: 30" diameter hole, depth per detail.
 - d. Boxed trees shall be twice the width of the root ball or a minimum of one foot all around, whichever is greater.
3. Set in Agriform fertilizer tablets per manufacturer's recommendations.
 4. Compact backfill in bottom of pit and tamp firmly. Set plants in center of pits in vertical position so that the soil level of the crown of the plant is flush with or slightly higher than the finish grade after the soil has settled. Backfill with prepared soil mix as described above.
 5. Do not spread amendments/prepared soil mix until approval of delivered materials has been received from the IOR and Owner's Representative.
 6. Form a shallow basin around the edge of tree ball by depressing the soil slightly below the finish grade. Do not raise basin rims above general finished grade. Keep basin within the edges of the tree ball. Each basin shall be of a depth to hold at least two (2) inches of water.
 7. Apply root hormone to each tree as follows:
 - a. Construct tree basins at rim or outer edge of the tree ball so that the water will stay on the top of the ball.
 - b. Apply root hormone at a rate of 2 ounces to 2 gallons of water. Pour it on the top of the tree ball within the basin rim. Immediately after applying root hormone, fill the tree basin with water and allow it to settle within the soil. Repeat applications of clear water once or twice, depending on the condition of the tree ball or as directed by the Architect or Owner's Representative.
 - c. Tree balls shall be set in their pits before application of root hormone and shall be mulched immediately after its application and its irrigation into the ball.
 - d. Apply a second feeding of root hormone in the same manner and amount as above during the maintenance period or within 30 days after the tree is planted, whichever is longer.
 - e. Each tree with a trunk of 12" diameter or less, in a lawn or where string trimmers are used, shall receive a tree trunk guard, to installed per manufacturer's specifications.

C. Shrub Installation

1. Plant shrubs in areas as designated on the Drawings.
2. Grade shrub and ground cover areas 2" below top of walks and curb. Float to a smooth, uniform grade as shown on Drawings. All areas shall slope to drain.
3. Where no grades are shown, establish a smooth and continuous grade between existing or fixed controls such as walks, curbs, catch basins and elevations at steps or buildings. Roll, scarify, rake and level as necessary to make a true, even surface. All finish grades shall meet the approval of the Architect or Owner's Representative before installation of ground cover. All grades shall slope to drain.
4. Loosen soil to a depth of 12" in shrub area and grade to remove ridges and depressions. Remove any additional stones and foreign matter over one half (1/2) inch in diameter from upper 8" of soil. Float areas to finish grade. Apply soil conditioners as specified above, mixing thoroughly into the soil to the depths indicated.
5. Do not pile soil around the crown of any plant. Smooth soil around plants and leave all areas in a neat and clean condition.

6. Water with a light spray.
 - D. Mulching: Apply 'Walk on Bark' or approved equal to all planting areas to a depth of four inches (3"). (unless decomposed granite is noted to be placed between plant material - see Plan) Mulch shall not be piled upon plant stems and trunks.
 - E. Grading: Grade areas around plants to finish grades and dispose of excess soil off the site.
 - F. Pruning: Prune plants according to standard horticultural practice as needed or as directed by the Architect or Owner's Representative.
 1. Tree Trimmer Qualifications: Company specializing in pruning trees with proof of ISA Arborist Certification and ISA Tree Worker Certification.
 2. Tree Pruning: ISA - Pruning Standards for Shade Trees.
 - G. Staking: Stake all trees as shown on Drawings and details with stakes on the windward side of trees. Tie stakes so as to avoid abrasion of the tree. All nursery stakes and ties shall be removed after planting.
- 3.04 DECOMPOSED GRANITE
- A. Do not install decomposed granite or crushed 3/8" or 1/4" minus aggregate paving during rainy conditions or below 40 degrees Fahrenheit and falling.
 - B. Blending Stabilizer
 1. Blend 12 to 16 lbs (call manufacturer for exact blend) of Stabilizer per 1-ton of decomposed granite or crushed 3/8" or 1/4" minus aggregate screenings. It is critical that Stabilizer be thoroughly and uniformly mixed throughout decomposed granite or crushed 1/4" or 3/8" minus aggregate screenings. Bucket blending is not acceptable. Blending with a rake and or shovel is not acceptable.
 - C. Placement
 1. After pre-blending, place the Stabilized decomposed aggregate or 3/8" or 1/4" crushed aggregate screenings on prepared sub-grade. Level to desired grade and cross section.
 2. Depth of pathways - 3" for heavy foot traffic and light vehicles.
 - D. Watering
 1. Water heavily to achieve full depth moisture penetration of the Stabilized pathway Profile. Water activates Stabilizer. To achieve saturation of Stabilized pathway Profile, 25 to 45 gallons of water per 1-ton must be applied. During water application randomly test for depth using a probing device to the final depth.
 - E. COMPACTION
 1. Upon thorough moisture penetration, compact aggregate screenings to 85% relative compaction by compaction equipment such as; a 2 to 4-ton double drum roller or a 1,000 lb. Single drum roller with vibratory plate tamp. Do not begin compaction for 6 hours after placement and up to 48 hours.
 2. Take care in compacting decomposed granite or crushed 3/8" or 1/4" minus aggregate screenings when adjacent to planting and irrigation systems. Hand tamping with 8" or 10" hand tamp recommended.
 - F. INSPECTION

1. Finished surface of pathway shall be smooth, uniform, and solid. There shall be no evidence of chipping or cracking. Cured and compacted pathway shall be firm throughout profile with no spongy areas. Loose material shall not be present on the surface. Any significant irregularities in the path surface shall be repaired to the uniformity of entire installation.

3.05 INSPECTION, START OF MAINTENANCE

- A. Inspection: An inspection shall be made of all planted areas by the Owner's Representative or by the Architect when the landscape installation is complete. The maintenance period will begin after approval by the Owner's Representative or the Architect. The Contractor shall give at least 7 days' notice in advance of the inspection time. If the Owner wants early completion of any portion of the project, "start maintenance for that portion may begin following inspection and approval by the Owner's Representative or the Architect.
- B. Maintenance Period
 1. The 90-day Maintenance Period begins at the end of the substantial construction completion date for the entire project.
 2. The Maintenance Period shall be 90 calendar days.
 3. Any day when the Contractor fails to adequately maintain plantings, replace unsuitable plants, control weeds, trash or other work as determined necessary by the Grounds Supervisor, will not be credited as one of the plant maintenance days.

3.06 MAINTENANCE OF LANDSCAPE AREAS

- A. Maintenance
 1. Before the start of the 90-day Maintenance Period, the Contractor is responsible for maintaining the installation. This period of maintenance responsibility is not part of the 90 day Maintenance Period that begins when the entire project is installed, inspected, and approved for "Start of Maintenance". If the Contractor fails the final inspection, the 90-Day Maintenance Period will begin when the Owner's Representative and the Architect are satisfied that the project is ready for "Start of Maintenance."
 2. If the Maintenance Period is extended beyond the 90 Day time because of rejection by the Owner's Representative or by the Architect, or for whatever reason, then the entire installation will remain the responsibility of the Contractor unless otherwise determined by the Owner's Representative.
 3. The year's guarantee of the trees begins at the end of the Maintenance Period. Any rejected material shall be replaced, and the 90-Day Maintenance Period shall be started from that time for the replaced material only.
 4. Maintain trees and plants in a vigorous, thriving condition by watering, cultivating, pruning, spraying, and any other necessary operation. Keep all shrubs free of weeds. Remove weed roots and stolons from the soil before planting and as necessary after planting.
 5. No stripping of lower branches ("raising-up") of young trees shall be permitted. Lower branches shall be retained in a "tipped back" or pinched condition with as much foliage as possible to promote caliper trunk growth (tapered trunk). Lower branches can be cut flush with the trunk only after the tree is able to stand erect without staking or other support. Sucker growth shall be removed if deemed appropriate by the Grounds Supervisor. Any pruning shall be conducted by a Certified Arborist.

6. Prune trees to select and develop permanent scaffold branches that are smaller in diameter than the trunk or branch to which they are attached which have vertical spacing of from 18" to 48" and radial orientation so as not to over lay one another; to eliminate diseased or damaged growth; to eliminate narrow V-shaped branch forks that lack strength; to reduce toppling and wind damage by thinning out crowns; to maintain growth within space limitations; to maintain a natural appearance; to balance crown with roots. Any pruning shall be conducted by a Certified Arborist.
7. Evergreen trees shall be thinned out and shaped when necessary to prevent wind and storm damage. The primary pruning of deciduous trees shall be done during the dormant season. Damaged trees or those that constitute health or safety hazards shall be pruned at any time of the year as required to eliminate these conditions. Any pruning shall be conducted by a Certified Arborist.
8. Tree trunks shall be always protected from any damage by maintenance equipment. Do not allow weed whippers to touch tree trunks.
9. The objectives of shrub pruning are the same as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the design and directed by the Grounds Supervisor.
10. All pruning cuts shall be made to lateral branches or buds or flush with the trunk, "Stubbing" will not be permitted.
11. Maintain all planting areas by watering, weeding, replanting, and other necessary operations. Keep planting areas free from weeds by removing roots and stolons and keeping the area in a clean and acceptable condition through the end of the Maintenance Period.
12. The Contractor shall check weekly all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each end of the lateral. All heads are to be adjusted as necessary for unimpeded coverage.

3.07 FINAL INSPECTION

- A. Owner's representative shall make a final inspection upon completion of the specified Maintenance Period.
- B. Contractor shall request final inspection in writing a minimum of 10 calendar days prior to anticipated date of inspection.
- C. All areas shall be weed-free, rodent/vermin free, with healthy growth and full turf/lawn establishment at the final inspection.

3.08 CLEAN UP

- A. Upon completion of all construction and before final acceptance, the Contractor shall broom clean entire paved area. All tools, surplus materials, equipment, debris, and rubbish shall be removed from the site and the site shall be left in a clean, neat condition such as to meet the approval of the Owner's Representative and/or the Architect. During the Maintenance Period, all hardscape/paving areas and gutters shall be clear of debris, leaves, trash etc.

END OF SECTION

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SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. In-Place Amendment of Planting Area Soil Surfaces.
2. Plant Pit Backfill Mix.
3. Stabilized Lawn Planting Mix.

B. Related Sections:

1. Section 32 01 30 – Operation and Maintenance of Site Improvements
2. Section 32 84 00 – Planting Irrigation
3. Section 32 84 13 – Drip Irrigation
4. Section 32 90 00 – Planting

1.02 REFERENCES

A. ASTM — ASTM International: D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

B. USDA — United States Department of Agriculture:

1. Soil Texture Triangle Classification.
2. Handbook No. 60.

1.03 DEFINITIONS

A. Acceptance, Acceptable, or Accepted: Acceptance by the Landscape Architect in writing.

B. Excessive Compaction: Planting area soil compaction greater than 75 percent of maximum dry density as determined by ASTM D 1557.

C. Landscape Architect: Landscape Architect employed by the Owner to provide professional landscape architectural services for the Project.

D. Drip Line: Line straight down from outermost limit of tree canopy branching.

1.04 SYSTEM DESCRIPTION

A. Backfill Mixes and Amended Planting Area Surface Soil: Uncompacted on-site soil with amendments incorporated uniformly to provide a well-draining, fertile medium for vigorous plant root growth.

- B. Soil Mixes: Uncompacted, imported topsoil with amendment incorporated uniformly to provide a well-draining, fertile medium for vigorous plant root growth.
- C. Structural Planting Soil Mix:
 - 1. Fast draining.
 - 2. Compacted to provide solid aggregate-to-aggregate contact to provide structural support for paving slabs and foundations of structures and sculptures.
 - 3. Uniform blend of aggregate and organic amendment that provides a fertile growing medium in the voids between the aggregate that retains moisture and nutrients for vigorous long-term plant root growth.
 - 4. Growing medium is not excessively compacted so that plant root growth is inhibited.

1.05 SUBMITTALS

- A. General Requirements: Refer to Division 1.
- B. Product Data:
 - 1. Chemical Amendments.
 - 2. Organic Soil Conditioner.
 - 3. Fertilizers.
 - 4. Polymeric Soil Conditioner.
 - 5. Organic Amendment.
 - 6. Coco Peat.
- C. Test Reports:
 - 1. Laboratory soil test reports indicating specified characteristics of soil, with test date no more than 2 weeks old.
 - 2. Laboratory soil test reports.
 - 3. Laboratory test report of organic amendment indicating specified characteristics of organic amendment, with test date no more than 2 weeks old.
 - 4. Sieve analysis of sand for sodded lawn planting mix with test date no more than 2 weeks old.
 - 5. Sieve analysis of sand for palm tree plant pit backfill mix.
- D. Purchase Documentation:
 - 1. Fertilizer Purchase and Delivery Invoices.
 - 2. Chemical Amendment Purchase and Delivery Invoices.

1.06 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 - 1. Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.
 - 2. Provide for inspections and permits required by federal, state and local authorities in furnishing, transporting, and installing materials.

B. Agronomic Testing Agency:

1. Send samples to Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245, and employ the laboratory to test the soil mixes and import soils.

C. Settlement Mock-Up:

1. Mock-up areas of backfill mix at specified depths and apply irrigation to induce settlement, to help determine the amount of settlement which will be caused by irrigation and rain.
2. Use settlement observed in mock-up to help determine allowances to make for settlement as required by this Section and other Sections.

1.07 SITE CONDITIONS

A. Environmental Requirements:

1. Do not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clods will not break readily.
2. Apply water, if necessary, to bring soil to an optimum moisture content for tilling.
3. Do not work soil when muddy or frozen.
4. Do not apply chemicals if wind conditions will cause hazardous drift to people or property.

B. Existing Conditions:

1. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing public underground utilities and structures with respective utility companies.
2. Prior to Work commencement review and clearly mark in field horizontal and vertical locations of existing private underground utilities and structures with the Owner's Designated Representative.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

A. Fertilizers:

1. Roots, Inc., Independence, Mo.; (800) 342-6173; www.rootsinc.com.
2. Vermi Technology Unlimited, Orange Lake, Fla; (352) 591-1111; www.vermitechnology.com.
3. Kelly's Green Team, Newark, Mo.; (660) 627-5500; www.kellysgreenteam.com.

B. Organic Amendments:

1. Earthworks Soil Amendments Inc.; (951) 782-0260; <http://www.ewsa.com>.
2. Aguinaga Green, Inc.; (949) 786-9558; <http://www.aguinagagreen.com>.

2.02 MATERIALS

A. Import Top Soil: Import top soil shall be classified as sandy loam, and must conform to the following:

1. Particle size

Class	Particle (Size Range)	Maximum %	Minimum %
a.	Coarse sand (0.5 - 2.0mm)	15	0
b.	Silt plus clay (<0.05mm)	50	15

Other classes:

c.	Gravel (2-13mm)	15	0
d.	Rock (1/2 – 1 inch)	5 percent by volume with none > 1 inch	

2. Chemistry

- Salinity: Saturation Extract Conductivity (ECe) - less than 3.0 sD/m @ 25° C
- Sodium: Sodium Absorption Ratio (SAR) - less than 6.0
- Boron: Saturation Extract Concentration - Less than 1.0 ppm
- Reaction: pH of Saturated Paste - 5.5-7.8 without high lime content

- Soil shall contain enough available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.
- To ensure conformance, samples of the import soil shall be submitted to an approved laboratory for analysis prior to and following backfilling.
- Obtain imported topsoil from approved local sources.

B. Organic Amendment:

- Fully composted aerobic humus compost without presence of decomposition products. The organic matter content shall be at least 50% on a dry weight basis. Humus material shall have an acid-soluble ash content of no less than 6% percent and no more than 20 percent.
- The pH of the material shall be between 6 and 7.5.
- The salt content shall be less than 10 millimho/cm at 25 degrees C on a saturated paste extract.
- Boron content of the saturated extract shall be less than 1.0 part per million.
- Silicon content (acid-insoluble ash) shall be less than 50 percent.
- Calcium carbonate shall not be present if the amendment is to be applied on alkaline soils.
- Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses, etc., low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
- Composted wood products are conditionally acceptable (stable humus must be present). Wood-based products are not acceptable which are based on redwood or cedar.
- Sludge-based materials are not acceptable.
- Carbon-nitrogen ratio shall be less than 25:1.

11. The compost shall be aerobic without malodorous presence of decomposition products.
12. The maximum particle size shall be 0.5-inch and 80 percent or more shall pass a No. 4 screen for mixing with soil. The maximum particle size for applying via hydroseeding machine shall be 0.25-inch.
13. Maximum total permissible pollutant concentrations in organic amendment in parts per million on a dry-weight basis:
 - a. Arsenic: 20
 - b. Cadmium: 15
 - c. Chromium: 300
 - d. Cobalt: 50
 - e. Copper: 100
 - f. Lead: 200
 - g. Mercury: 10
 - h. Molybdenum: 20
 - i. Nickel: 100
 - j. Selenium: 50
 - k. Silver: 10
 - l. Vanadium: 50
 - m. Zinc: 200
14. Higher amounts of salinity or boron may be present if the soils are to be pre-leached to reduce the excess or if the plant species will tolerate the salinity and/or boron.
15. From 45- to 65-percent moisture measured via wet-weight basis.
16. Free of stones and debris.
17. Tests 5 to 8 on Solvita Test.

C. Fertilizers:

1. Roots "M-Roots" with mycorrhiza 3-3-3.
2. Kelley's Green Team Gypsum Fairway Pellets, 76-percent calcium sulphate dehydrate, 17-percent calcium; 14-percent sulfur, derived from mined gypsum, less than 1-percent moisture content.
3. Vermi Technology pure black worm castings produced without waste products; free of larva, sticks, stones, and debris; 48 percent by weight minimum organic content per ASTM D2974; complying with the following:

Item	Criteria
a. Total Ash	48 percent to 52 percent
b. pH:	5.0 to 7.5
c. % Moisture (wet wt. basis:	30 percent to 50 percent
d. Solvita Rating:	> 8

D. Potential Chemical Amendments Required by Accepted Amendment Program and Backfill Mix:

1. Ground Limestone: Agricultural limestone containing not less than 85 percent of total carbonate, ground to such fineness that 50 percent will pass No. 1 sieve and 90 percent will pass No. 20 sieve.
 2. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35 percent minimum magnesium carbonate and 49 percent minimum calcium carbonate, 100 percent passing No. 65 sieve.
 3. Gypsum: Agricultural grade product containing 80 percent minimum calcium sulfate.
 4. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20 to 30 percent iron and 35 percent to 40 percent sulfur.
 5. Sulfate of Potash: Agricultural grade containing 50 to 53 percent of water-soluble potash.
 6. Single Superphosphate: Commercial product containing 20 to 25 percent available phosphoric acid.
 7. Ammonium Sulfate: Commercial product containing approximately 21 percent ammonia.
 8. Ammonium Nitrate: Commercial product containing approximately 34 percent ammonia.
 9. Calcium Nitrate: Agricultural grade containing 15-1/2 percent nitrogen.
 10. Urea Formaldehyde: Granular commercial product containing 38 percent nitrogen.
 11. IBDU (Iso Butyldiene Diurea): Commercial product containing 31 percent nitrogen.
 12. Soil Sulfur: Agricultural grade sulfur containing a minimum of 96 percent sulfur.
 13. Silicic Acid Calcium: Commercial grade.
- E. Polymeric Soil Conditioner: Twenty to 25 percent anionic polyacrylamide, water-soluble, linear, 7,500,000-dalton, soil aggregating polymer containing a minimum of 20,000 soil binding sites proven to be efficacious.
- F. Sand for Stabilized Lawn Mix: TLC USGA Greens Sand (909) 594-2696.
- G. Soil Reinforcement Fiber for Stabilized, Civic Green Lawn Mix: Stalok Fiber G-400 as available from Stabilizer Solutions, Phoenix, AZ; (800) 336-2488; www.stabilizersolutions.com.
- H. Sand for Structural Soil Mix: TLC USGA Greens Sand (909) 594-2696.

2.03 MIXES

- A. Preliminary Plant Pit Backfill and Shrub Import Profile Mix to Establish Bid (actual quantities contingent on amendment program determined by the soil test report):
1. Content:
 - a. 8 cubic feet of organic amendment per cubic yard of dry import topsoil.
 - b. 1-pound dry polymeric soil conditioner per cubic yard of dry soil.
 - c. 1/2-pound Triple Superphosphate 0-45-0 per cubic yard of dry soil.
 - d. 1-pound of Nitroform 38-0-0 per cubic yard dry soil.
 - e. 1-pound of Potassium Sulfate 0-0-50 per cubic yard dry soil.
 - f. 2-pound of Gypsum per cubic yard dry soil.
 2. Mixing:

- a. Blend materials uniformly with 50 percent dry existing soil excavated from plant pits and 50 percent dry imported topsoil in bulk by turning over materials with an end loader.
 - b. Blend materials in a clean area which will not contaminate the mix.
 - c. Do not mix in planting areas.
- B. Final Plant Pit Backfill Mix for Installation: Backfill mixes determined by the soil test report.
- C. Preliminary In-Place Amendment of Planting Area Surfaces to Establish Bid (actual quantities contingent on amendment program determined by the soil test report):
1. Rip existing soil to a depth of 9 inches and homogeneously incorporate the following amendments to a 6 inches depth (rates are per 1,000 square feet):
 - a. Ammonium Sulfate (21-0-0) – 5 lbs.
 - b. Potassium Sulfate (0-0-50) - 5 lbs.
 - c. Triple Superphosphate (0-45-0) – 5 lbs.
 - d. Agricultural gypsum – 15 lbs.
 - e. High quality soil amendment – 3 cubic yards.
- D. Final In-Place Amendment of Planting Area Surfaces: Determined by the soil test report.
- E. Sodded Lawn Planting Mix:
1. Sand with peat moss.
 2. Ten pounds of nylon fibers per ton of sand.
- F. Structural Soil Mix:
1. Mix to Establish Bid: 3 parts USGA Greens Sand, 1 part composted organic amendment with peat moss.
 2. Final Mix for Construction: Job Mix Formula determined by the Testing Laboratory
- 2.04 SOURCE QUALITY CONTROL
- A. Organic Amendment: Employ independent soil testing laboratory to test organic amendment for specified properties and submit test results.

PART 3 EXECUTION

3.01 EXAMINATION

- A. General: Examine site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.
- B. Subgrade:
1. Verify that the subgrade is at the correct elevation and slope.
 2. Inspect soil surface for sticks, oils, chemicals, plaster, concrete, and other deleterious materials.

3. Remove deleterious materials.
- C. Underground Utilities and Structures: Verify that the locations of utilities, structures and other underground items have been clearly marked.
- D. Notification of Unsuitable Conditions: Before proceeding with Work, notify the Owner's Designated Representative in writing of unsuitable conditions and conflicts.
- E. Soil Tests to Determine Final Plant Pit Backfill Mix, Planting Area Soil Surface Amendment Programs, and Maintenance Period Fertilization Programs:
1. Take fifteen 1-pound composite representative soil samples from locations determined by the Landscape Architect in the field.
 2. Send samples to Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245, and employ the laboratory to test the soil samples for the following:
 - a. pH measurement in the saturation extract per USDA Handbook No. 60, Method 21.
 - b. Electrical conductivity of the saturation extract per USDA Handbook No. 60, Method 2.
 - c. Sodium absorption ratio of the saturation extract per USDA Handbook No. 60, Method 20b.
 - d. Determination of boron, calcium, copper, iron, magnesium, manganese, molybdenum, phosphorous, potassium, sodium, sulfur, and zinc, via the following test methods: Mehlich Number 3, Bray P1, Bray P2, Olsen P, DTPA, ammonium acetate, ammonium bicarbonate DTPA, and hot water extract from boron.
 - e. Analysis of saturation extract for calcium, magnesium, sodium, boron, chloride, phosphorous, nitrate, and sulfate.
 - f. Measurement of following trace metals by the DTPA extract: aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, nickel, selenium, silver, strontium, tin, and vanadium.
 - g. Presence of calcium carbonate and magnesium carbonate.
 - h. Estimate of soil texture per commonly used methods.
 - i. Estimate of organic matter content per commonly used methods.
 - j. Exchangeable Ammonium Cation.
 - k. Base Saturation.
 - l. Cation Exchange Capacity.
 - m. Carbonates Determination.
 - n. Soil Bulk Density.
 - o. Water Infiltration Rate per USDA Handbook No. 60, Method 34b.
 3. At least 30 days prior to commencement of soil preparation Work, submit to the Landscape Architect the laboratory's written soil test report including the laboratory's soil test data; the laboratory's interpretation of nutritional deficiencies, excesses, and potential toxicities; the laboratory's amendment recommendations; and the laboratory's maintenance recommendations.
- F. Soil Tests for Parasitic Nematodes:

1. Test soils which have been used for agricultural purposes within the prior 12 months for parasitic nematodes.
2. Soil will be acceptable if the parasitic nematode population is less than 200 per 50 cubic centimeters of soil.
3. Do not artificially dry soil prior to testing.
4. Submit written test report to the Architect/Engineer and Horticultural Consultant.

G. Soil Tests for Herbicide Contamination:

1. Perform a radish/rye grass growth trial on soils suspected of herbicide contamination.
2. Submit written test report to the Architect/Engineer and Horticultural Consultant.

3.02 WEED ERADICATION PROGRAM OF EXISTING VEGETATION AT PLANTING AREAS

- A. Six weeks prior to planting and before tilling or amending planting areas, spray existing vegetation with 3 percent Glyphosate solution and repeat treatment 3 weeks later to kill re-emerging vegetation.

3.03 PREPARATION OF SUBGRADE TO RECEIVE IMPORTED SOIL MIXES

A. Protection:

1. Use every possible precaution to prevent damage to existing conditions such as structures, utilities, irrigation systems, plant materials and paving on or adjacent to the site of the Work.
2. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
3. Provide barricades, fences, or other barriers to protect existing conditions to remain from damage and excessive compaction during construction.
4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
5. Submit written notification of conditions damaged during construction to the Owner's Designated Representative immediately.

B. Ripping Subgrade Soil:

1. Prior to placing topsoil, rip areas to receive topsoil on the same day topsoil is placed.
2. Rip subgrade twice to a depth of 6 inches unless indicated otherwise.
3. Space ripping tines at 24 inches on center.
4. Make second ripping pass in a direction 90 degrees to the direction of the first ripping pass.
5. Do not rip closer than 2 feet horizontally and vertically to installed and existing utility lines and structures.

C. Location and Depths: As indicated on the Drawings.

D. Mix Placement:

1. Place soil mixes same day that subgrade soil ripping occurs and prior to vehicle or equipment traffic running over the ripped surface.

2. Place soil mixes with equipment of appropriate size for area and in a manner that avoids excessive compaction of the topsoil.
 3. Avoid repeatedly driving equipment on the same tracks so that topsoil does not become excessively compacted.
- E. Allowances: Place topsoil to elevations that allow for settlement, addition of soil amendment, and finish grading tolerances.
- F. Finished Grade: See Section 32 91 19.
- G. Surface Drainage: Keep soil surface sloped so that surface drains.
- H. Compaction and Contamination:
1. In handling materials and operating tools and equipment, protect the topsoil from excessive compaction by laying down planks, plywood, or other accepted protective devices.
 2. Do not store or stockpile materials on the topsoil.
 3. Do not allow vehicles to park or drive on topsoil, except equipment which is preparing and finish grading the soil.
 4. If ruts are formed, blade rutted topsoil smooth.
 5. Loosen excessively compacted soil to the full depth of the excessive compaction, rototill, and grade surface smooth.
- I. Excessively Compacted Topsoil:
1. Mechanically loosen excessively compacted topsoil to its full depth via a method acceptable to the Landscape Architect and re-grade surface smooth.
 2. Keep topsoil from being excessively compacted until date of Final Completion.
- J. Erosion Repair:
1. Repair erosion that occurs between topsoil installation and plant or seed installation.
 2. Fill eroded areas with topsoil and finish grade.
- 3.04 PREPARATION OF SOIL SURFACE OF PLANTING AREAS
- A. Protection of Existing Conditions:
1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, plant materials and walks on or adjacent to the site of the Work.
 2. Use every possible precaution to prevent excessive compaction of planting area soil within or adjacent to the areas of Work.
 3. Provide barricades, fences or other barriers to protect existing conditions to remain from damage during construction.
 4. Do not store materials or equipment, permit burning, or operate or park equipment under the branches of existing plants to remain.
 5. Submit written notification of damaged plants and structures to the Owner's Designated Representative immediately.
- B. Surface Preparation:

1. Inspect soil surface for sticks, oils, chemicals, plaster, concrete, and other deleterious materials.
2. Do Work required to remove and dispose of the deleterious materials.

C. Excessively Compacted Areas:

1. Where tilled planting soil or imported planting soils have become compacted more than 75-percent maximum dry density per ASTM D 1557 rip soil to 4 inches below the depth of the excessive compaction.
2. Space ripping tines at 18 inches on center.

3.05 AMENDMENT OF SOIL SURFACE OF PLANTING AREAS

- A. Preliminary Amendment Program to Establish Bid for existing soil Areas in Planting Areas Not to Receive Topsoil: 3 cubic yards of organic amendment per 1,000 square feet, 9 pounds of Nitroform 38-0-0 per thousand square feet, and 2.5 pounds of Triple Superphosphate 0-45-0 per thousand square feet, 10 pounds of Potassium Sulfate 0-0-50 per 1,000 square feet, 20 pounds of polymeric soil conditioner per 1,000 square feet, 30 pounds of Gypsum per 1,000 square feet.
- B. Preliminary Amendment Program to Establish Bid for Areas with Imported Topsoil: 6 cubic yards of organic amendment per 1,000 square feet, 20 pounds of polymeric soil conditioner per 1,000 square feet, 20 pounds of Nitroform 38-0-0 per 1,000 square feet, 10 pounds of Potassium Sulfate 0-0-50 per 1,000 square feet, and 5 pounds of Triple Superphosphate 0-45-0 per 1,000 square feet, 30 pounds of Gypsum per 1,000 square feet.
- C. Final Amendment Programs for Installation: Determined by soil test report results.
- D. Amendment Incorporation:
 1. Spread dry amendments evenly over surface of dry soil with a drop spreader.
 2. Organic amendment and soil must be dry.
 3. Incorporate amendments uniformly within top 6 to 8 inches of soil within a few hours after amendment application, except at areas within drip lines of existing trees to remain.
 4. At areas within drip lines of existing trees to remain, incorporate amendments uniformly to 1 to 2-inch depth within a few hours after application.
 5. Mechanically incorporate the amendments into the soil via a method that will not excessively compact the soil below incorporated amendments.
 6. To activate polymeric conditioner, irrigate soil very slowly so that soil surface will not form a crust and until water penetrates 6-inch depth.
 7. Allow soil to dry until stringiness disappears.
 8. Prior to planting, re-till soil to a 6-inch depth at areas outside of drip lines of existing trees to remain and re-till soil to a 1 to 2-inch depth at areas within drip lines of existing trees to remain.

3.06 STRUCTURAL PLANTING SOIL MIX

A. Placement:

1. Place mix carefully avoiding damage or displacement of other materials such as walls, paving, waterproof membrane, protection board, drain rock, geotextile fabric, and irrigation piping.

2. Do not mix subgrade soils or construction materials with soil mix.
3. Remove soil mix contaminated with subgrade soil, construction materials, or debris.
4. Place soil mix to depths, elevations, and profiles indicated on the Drawings.

B. Compaction:

1. Place soil mix in 6-inch lifts.
2. Compact each lift to 90 percent of maximum density achievable.

C. Settlement Repair: Fill settled low areas with soil mix and repeat compaction and filling process until settlement ceases.

D. Fertilizer Application after Soil Mix Placement:

1. Apply gypsum pellets at rate of 20 pounds per 1,000 square feet.
2. Apply 3-3-3 at rate of 20 pounds per 1,000 square feet.
3. Uniformly spread half of each fertilizer in one direction and spread other half of each fertilizer in direction 90 degrees to direction that first half was spread.
4. Sprinkle surface of soil mix with 2 inches of water after application of fertilizers.

3.07 FIELD QUALITY CONTROL

A. Soil Amendment Verification:

1. Employ the same soil testing laboratory used to test the soil as indicated in Article 3.1 E of this Section, to take up to 10 random composite samples of amended soil surface areas and soil mixes for laboratory testing to verify amendment composition.
2. Perform corrective work as recommended by the laboratory soil test reports.
3. When a laboratory soil test indicates that the soil or soil mixes meet the requirements of the Specifications the Contractor will receive written notification of acceptance from the Landscape Architect.
4. Installation of ground cover plants and seed may commence upon Contractor's receipt of the written notification of acceptance.

END OF SECTION

SECTION 32 92 19

SEEDING

PART 1 GENERAL

1.01 WORK INCLUDED:

- A. Furnish all labor, material, equipment, and services necessary to provide all seeding and hydromulching, complete and in place, as shown and specified.
- B. Work includes:
 - 1. Preparation
 - 2. Option 1: Hydromulching
 - 3. Option 2: Land Imprinting
 - 4. Option 3: Drill Seeding
 - 5. Application of mycorrhizal inoculum
 - 6. Cleanup

1.02 RELATED SECTIONS

- A. Section 32 01 30 – Operation and Maintenance of Site Improvements
- B. Section 32 84 00 – Planting Irrigation.
- C. Section 32 84 13 – Drip Irrigation.
- D. Section 32 90 00 – Planting

1.03 REFERENCES

- A. Latest version of American Society for Testing and Materials (ASTM) standards: ASTM D 422. Standard Test Method for Particle-Size Analysis of Soils.

1.04 SUBMITTALS AND NOTIFICATIONS

- A. Submit documentation to Architect within twenty-five (25) days after award of Contract that all required seed is available. No substitutions may be made without the approval of the Architect. Requests for substitutions due to unavailability must be made in writing.
- B. Materials List and Seed Certification:
 - 1. A complete material list shall be submitted to the Architect prior to performing any work. Material list shall include all hydromulches, binders, seed, etc.
- C. Submit to the Architect a one-pound sample of each type of seed mix specified.
 - 1. The sample shall be drawn from the same lots used for the seeding work.
 - 2. A Registered Seed Technologist shall have tested all seed at a Certified Seed Laboratory within 15 months of delivery to the site.

3. Attach seed tags and test copies for each lot of seed.
- D. The Contractor shall notify the Architect in writing a minimum of 7 days prior to starting seeding work. The notice shall state the equipment to be used (including manufacturer's data sheets), the date and time that operations will start, and the name of the person in the field who will oversee the work.
- E. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Architect a minimum of 24 hours prior to the resumption of work.

1.05 SOIL TEST:

- A. The contractor shall have imported soil and the soil of the site tested for fertility, agricultural suitability, and appraisal by Soil and Plant Laboratory Inc. (714) 282-8777, or Wallace Labs (310) 615-0116.
 1. The contractor will inform the laboratory, prior to test analysis, of the seed mix to be planted, and that mycorrhizal inoculum will be used.
 2. Soil shall be tested from a minimum of four (4) locations per acre of planted area. Contractors shall record locations where samples were taken.
 3. A copy of the soil test results shall be submitted to the Owner and Architect before work begins.
 4. Contractor shall pay cost of soil test.

1.06 STANDARDS:

- A. A Registered Seed Technologist shall have tested all seed at a Certified Seed Laboratory within 15 months of delivery to the site.
- B. Provide seed that meets or exceeds specifications of Federal, State, and County laws requiring inspection for plant disease or insect control.
- C. Provide seed that is true to botanical name. In all cases, botanical names shall take precedence over common names.
- D. Workmanship: Perform work in accordance with the best standards of practice for landscape work and under the continual supervision of a competent foreman capable of interpreting the drawings and specifications.

1.07 VERIFICATION OF DIMENSIONS AND QUANTITIES:

- A. All scaled dimensions are approximate. Before proceeding with any work, carefully check and verify all dimensions and quantities and immediately inform the Architect of any discrepancy between the drawings and/or specifications and actual conditions. No work shall be done in any area where there is any such discrepancy until the Architect has given approval for the work.

1.08 OBSERVATION SCHEDULE

- A. Contractor shall be responsible for notifying the Architect in advance for the following observations according to the time indicated:
 1. Pre-construction conference - 7 days
 2. Seeding area layout review - 72 hours
 3. Seeding operations - 48 hours

4. Completed seeding - 7 days.

- B. Contractor shall be responsible for scheduling site Observation visits with Architect as work progresses. Failure to schedule required Observations shall not relieve Contractor of responsibility for obtaining approvals. Work that must be redone to satisfy these requirements shall be done by the Contractor at no cost to Owner.
- C. Observations may be waived or combined at the discretion of the Architect.
- D. When someone other than the Architect conducts Observations, the Contractor shall show evidence in writing of when and by whom these observations were made.
- E. No site visits shall commence without adequate preparation, or all items noted in previous Observation Reports either completed or remedied unless the Architect has waived such compliance. Failure to adequately prepare or accomplish previous punch list items shall make the Contractor responsible for reimbursing the Architect for the site visit at his current billing rates per hour plus transportation costs. No further inspections will be scheduled until this charge has been paid and received.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver all seed to the jobsite in unopened containers with legible identification labels. Each seed package shall have a complete seed test analysis attached, stating seed lot number, botanical species, dealer's guarantee of percentage of Purity, Inert, Crop, and Weed, as well as Germination, test date, and certificate or stamp of release by a County Agriculture Commissioner.
- B. Store seed material in shade and protect from weather or injury. Maintain in a dry condition, and at a consistent temperature. Architects may at any time reject seed not maintained in this condition.
- C. Deliver non-seed products to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark, and conformance to state law. Protect material from damage or breakage. Immediately remove empty containers from the site.

1.10 SAMPLES AND TESTS:

- A. Architects reserve the right to take and analyze samples of materials for conformity to specifications at any time.
- B. Contractor shall furnish samples upon request by Architect.
- C. Rejected materials shall be immediately removed from the site at the Contractor's expense.
- D. Contractor shall pay the cost of testing of materials that do not meet specifications.

1.11 WARRANTY AND REPLACEMENT

- A. The contractor shall reseed any poorly or inadequately germinated areas until each area has germinated a full and healthy stand of the specified plant species.

PART 2 PRODUCTS

1.12 SEED

- A. Fresh, clean, new crop seed.
 - 1. For slurry applications: mechanically mix to specified proportions.
 - 2. For drill applications: mix for appropriate seed boxes.
 - 3. For imprinting applications: mix according to these specifications.

1.13 SOIL AMENDMENTS

- A. Soil amendments shall be as required by the Soils Test.
- B. The contractor shall provide all amendments recommended by the Soils Report at no additional cost to Owner.

1.14 MYCORRHIZAL INOCULUM

- A. Mycorrhizal inoculum shall consist of spores, mycelium, and mycorrhizal root fragments in a solid carrier suitable for handling by hydro-seeding or dry seeding equipment. The carrier shall be the material in which the inoculum was originally produced, and may include organic materials, vermiculite, perlite, calcined clay, or other approved materials consistent with mechanical application and with good plant growth.
- B. Mycorrhizal fungal species shall be suitable for the ph of the soil at the planting site and for the use of the seeds being sown. If the inoculum consists of a mixture of species, no more than 20% of the claimed propagule count shall consist of fungal species known to be unsuitable for the ph of the soil at the planting site.
- C. Mycorrhizal inoculum is a live material. It shall be stored, transported, and applied at temperatures of less than 32° F or greater than 90° F.
- D. Inoculum shall have a guarantee of at least 220 live propagules per kilogram (100 live propagules per pound). Inoculum shall be applied at the rate of 67 kilograms per hectare (60 lb. per acre).

1.15 HYDROMULCHING FERTILIZERS:

- A. Soil additives and fertilizers will be as recommended by the required Soils Test.

1.16 FIBER MULCH:

- A. Fiber mulch shall be derived from recycled newsprint paper and dyed green, such as 'Enviro Fiber S-100 Hydroseeding Mulch' (no known equal). Newsprint is proven superior in water-holding capacity, seed protection and stability.
- B. Application rate: 2000 pounds per acre.
- C. Wood fiber mulch is not acceptable.

1.17 SOIL STABILIZER BINDER ADDITIVE:

- A. Shall be an organic hydromulching tackifier additive composed of finely ground muciloid outer layer of a seed.

PART 3 EXECUTION

1.18 INSPECTION AND ORGANIZATION

- A. Site acceptance:
 - 1. The Contractor shall be responsible for verifying grades and site conditions before beginning work.
 - 2. No change in Contract price will be allowed for actual or claimed discrepancy between existing grade and those shown on the plan after Contractor has accepted existing grades and moved on the site.
 - 3. The Contractor shall be responsible for any damage seedlings after installation prior to acceptance by Owner.
- B. Scheduling: Perform seeding only when weather and soil conditions are suitable, as approved by Architect.
 - 1. Finish grading shall be complete prior to seeding.
 - 2. The irrigation system shall be operational and approved prior to seeding.
 - 3. In areas where applicable, install trees and shrubs prior to seeding.

1.19 AREA PREPARATION

- A. Topsoil shall not be stripped and shall remain in place.
- B. Complete clearing and grubbing to the Architect's satisfaction. At time of seeding, the surface of all areas to be seeded shall be free of large stones, sticks, stumps, or other deleterious matter one inch in diameter or larger, and shall be free from all wire, plaster, construction debris of any kind, or similar objects that would be a hindrance to seeding or maintenance.
- C. Stage the clearing work in areas small enough to insure that seed application will take place before any significant soil erosion will occur. The Contractor shall be responsible for preventing and repairing any soil erosion that occurs during the area preparation.
- D. Clearing and weed control (level areas) - Approximately 3 weeks are needed to complete proper weed abatement. December through February are preferred months for this operation. Schedule may be extended or adjusted depending on weather conditions: colder temperatures and rainfall can add several weeks to the effectiveness of the work.
 - 1. Apply irrigation to encourage weed growth prior to clearing, and to maintain moisture in the soil.
 - 2. Clear weed growth to expose bare soil.
 - 3. Lightly disk to a depth of three inches, followed by a heavy roller.
 - 4. Perform one "grow and kill" cycle after first disking and prior to seeding:
 - a. Watering and fertilizing to encourage weed germination.
 - b. Follow with a second light harrowing or disking to kill the weeds.
 - 5. A heavy roller should be used behind the disc. The second disking ("grow and kill") may also be the final seedbed preparation if seeding immediately follows.
 - 6. Prepare the seed bed immediately prior to seeding on slopes five to one (5:1) or flatter by lightly tilling, harrowing, or disking the soil to a depth of 3".

- E. Clearing and weed control (slopes) - Approximately 6-8 weeks are needed to complete proper weed abatement. December through February are preferred months for this operation. Schedule may be extended or adjusted depending on weather conditions: colder temperatures and rainfall can add several weeks to the effectiveness of the work.
1. The guidelines outlined below are for two full herbicide applications and thorough clearing of the slopes of treated vegetation prior to applying new hydroseed material.
 2. The goal is to hydroseed in the first part of March to benefit from the spring growing season.
 3. Regular inspections and diligence are necessary during all stages of weed abatement.
 - a. Apply contact herbicide to all slope areas after seasonal rains and overhead irrigation has helped germinate weed seeds and 3" to 4" of vegetative growth has occurred. Apply contact herbicide thoroughly to all plants per Manufacturer's guidelines.
 - b. After several days, provide more irrigation on slopes to help encourage plant growth.
 - c. Inspect weed kill progress for 1-2 weeks. Begin removal of dead vegetation where weed kill is successful and rake to remove excess foliage.
 - d. Continue regular irrigation of slopes to encourage additional seed germination for two more weeks.
 - e. Repeat application of herbicide to kill any new seedlings.
 - f. If the weather is cool and overcast, weed growth should be allowed to continue for 3-4 weeks to achieve optimum germination.
- F. Apply soil amendments specified in the Soils Report at the time of the final seedbed preparation at the rates specified.
- G. Prior to seeding, make light applications of irrigation to achieve the optimum germination moisture level in the soil.
- H. Contractor shall be responsible for shaping all seeding areas as indicated on plans or as directed by Architect. Layout and preparation are to be approved by Architect before seed application begins.
- 1.20 APPLICATION OF MYCORRHIZAL INOCULUM BY DRY BROADCASTING
- A. Mycorrhizal inoculum may be incorporated into the hydroseed mix or imprinting operation. If incorporation with the seeding operation is not possible, use the dry broadcast method outlined here.
 - B. Mycorrhizal inoculum shall be broadcast on the soil surface by means of a mechanical device that does not grind or unduly compress the carrier granules or fungal spores.
 - C. The inoculum shall be incorporated into the soil within three hours of broadcasting. Incorporation shall be accomplished by disking, tilling, harrowing, track walking, or ripping the soil, and shall result in incorporation of 80% of the inoculum granules to a depth of 2 to 10 cm (1 to 4 inches).
 - D. Inoculum shall be placed prior to application of seeds.
- 1.21 OPTION 1 - HYDROSEED APPLICATION:

- A. Application of mycorrhizal inoculum by hydro-seed equipment
1. Mycorrhizal inoculum shall be applied in the same application as the seeds. In no case shall Mycorrhizal inoculum be applied after the seeds. Inoculum must be applied within one hour of addition to the mixing tank.
 2. The following mixture in the proportions indicated shall be applied with hydroseeding equipment within 60 minutes after the seed has been added to the mixture:
 3. If temperatures will exceed 90° F, remaining erosion control applications must be applied within three hours of the application of the inoculum.
- B. Hydroseed shall be applied in a two step process with an approximate 24 hour drying time between steps. The first step is hydraulic application of the seed and soil amendment slurry directly to the soil surface. The second step is hydraulic application of the germination layer over the top of the seed. The germination layer consists of fiber mulch and tackifier slurry.
1. Prepare and apply slurries in the proportions and quantities stated on the contract drawings.
 2. Slurry preparation shall take place at the work site and shall begin by adding water to the tank when the engine is at half throttle.
 3. Equipment:
 - a. Hydraulic equipment used for the application of the fertilizer, seed and slurry of prepared wood pulp shall have a built-in agitation system and operating capacity sufficient to agitate, suspend and homogeneously mix a slurry containing not less than 40 lbs. of fiber mulch plus a combined total of 7 lbs. additive solids for each 100 gallons of water.
 - b. The slurry distribution lines shall be large enough to prevent clogging and shall be equipped with a set of hydraulic spray nozzles that will provide a continuous non-fluctuating discharge.
 4. Application: The operator shall spray with a uniform visible coat, using the color of the applied slurry as a guide. Apply the slurry in the correct amount to distribute the specified quantities over the specified areas.
 5. Time Limit: all slurry mixture which has not been applied within two hours after mixing will be rejected and removed from the project and disposed of at the Contractor's expense.
 6. Protection: The Contractor shall exercise special care to prevent any of the slurry from being sprayed outside the designated areas. Any slurry spilled into restricted areas shall be cleaned up at the Contractor's expense to the satisfaction of the Architect.
 7. Immediately following application of hydromulch, the Contractor shall wash excess material from trees, shrubs, fences, valve boxes, equipment markers, or architectural features. Care shall be exercised to avoid washing or eroding mulch materials from the area.

1.22 OPTION 2 - DRILL SEEDING APPLICATION:

- A. Apply soil amendments specified by the Soils Report at the time of the final seedbed preparation at the rate specified.
1. Prior to seeding, make light applications of irrigation in order to achieve the optimum germination moisture level in the soil.
 2. Apply seed mixes specified on the contract drawings by mechanical seed drill designed for drilling native grass seed mixes. The drill shall have separate boxes for large, medium, and small seeds. Mix vermiculite with the seed mixes as necessary to achieve

optimum balancing of seed rates. Test and calibrate the drill rig over a concrete surface to ensure the proper rates are being delivered. A minimum of 150 live seeds per square meter shall be planted.

3. The drill shall open the seedbed, deliver the seed to the proper depth, and close the soil over the seed.
4. A heavy roller shall follow the drill and compress the seed in the seedbed to ensure the seed is in firm contact with moist soil. Native grass seed requires more compression than most agricultural crops.

B. The operator shall fill out daily worksheets. One copy shall be delivered to the Architect. The following shall be recorded:

1. Seed - type, amount
2. Area covered in acres
3. Equipment used - license number if applicable.
4. The drill operator's and the Architect's signatures on the worksheet.

1.23 OPTION 3 - SEED APPLICATION (LAND IMPRINTING)

A. Equipment:

1. Characteristics of imprinting teeth:
 - a. The height of the imprinting teeth shall be at least four inches.
 - b. Imprinting teeth shall be V-shaped in transverse section and may be rectangular or triangular in longitudinal section.
 - c. Any imprinter used on a slope greater than 4:1 shall have teeth ten inches or less in length, with a gap of two inches or more between the end of one segment and the beginning of the next. If the imprinting teeth are longer than ten inches, the machine shall be always operated with the long dimension in a horizontal orientation to the slope.
 - d. The crest-to-crest spacing between teeth shall be less than two feet. One foot is often optimum for land restoration.
 - e. The apical angle of the triangular cross section of the imprinting teeth shall be ninety degrees or less, with acute teeth preferred for the steepest slopes.
 - f. Any imprinter used on a slope greater than 2:1 shall have a "saw tooth" pattern, in which the apex of the tooth is offset, giving a long and a short side to each tooth. The angle between front and rear faces of the imprinting teeth shall be 60 degrees or less. The imprinter shall be operated so that the long face of the impressions lays upslope of the short face.
2. Weight per unit area on teeth
 - a. The static pressure on the soil surface is measured by dividing the total weight of the imprinter, including any ballast, by the total area of tooth contact when the teeth have penetrated halfway into the soil.
 - b. The static pressure on the soil surface shall be at least 12 pounds per square inch and less than 48 pounds per square inch. The lower weights are for softer soils and the higher weights for harder or drier soils.
 - c. No more pressure shall be used than that required to obtain a full-tooth imprint.
3. Maximum length of roller

- a. No individual roller shall be more than eight feet in length, except in the case of level, rock-free land that will not cause a long roller to leave unimprinted areas.
 - b. More than one roller may be attached to a single imprinting device as long as each roller swivels independently over surface obstructions. In this case, the combined rollers may be any practical width.
4. Effects and type of tractor
 - a. The tracks or wheels of the moving tractor shall produce less pressure on the soil than the properly weighted imprinter.
 - b. If the slope is too steep to safely operate a tractor-drawn imprinter, the imprinter may be pulled up and down by means of a winch.
- B. Condition of Soil:
1. The soil may be imprinted when dry if it is soft enough to allow penetration of the imprinting teeth to their full depth, and firm enough to permit the formation of smooth-walled, firm impressions. If the dry soil does not allow formation of quality impressions, it shall not be imprinted until rainfall or irrigation leaves it in a suitable condition.
 2. Soil that is too hard to accept a pattern that conforms to performance specifications with a properly weighted imprinter shall be ripped before imprinting. Adjustment of the imprinter ballast is preferred over ripping where feasible.
 3. Clay soil shall not be imprinted while it is so wet that substantial quantities of it stick to the roller.
- C. Form of impressions
1. Impressions shall be of V-shaped cross section and ten inches or less in length if used on a slope exceeding 4:1.
 2. A pyramidal shape is acceptable if the apical angles between all faces are ninety degrees or less.
 3. The imprinting pattern shall provide a raised soil ridge that prevents continuous movement of drainage water between impressions.
 4. At least 70% of the soil surface shall bear impressions, apart from any peripheral turn-around area and areas rendered untreatable by rocks or other natural features.
 5. At least 70% of the impressions shall reach 90% of the full tooth depth.
 6. At least 70% of the impressions shall have smooth and firm soil over at least 70% of their surface area.
- D. Operating procedures
1. The optimum operating speed is three to four miles per hour.
 2. The imprinter shall be pulled at a speed low enough to ensure that the full weight of the roller always bears upon the soil.
 3. If the impressions are longer than ten inches, the long dimension of each imprint shall lie parallel to the contour of the slope.
 4. If imprint length is ten inches or less, the imprinter may be used in any orientation to the slope.
- E. Proximity to edges of seeded area
1. The imprinting pattern shall extend fully to the boundaries of the project area.

2. The area at the project boundary may serve as a turn-around area and normally will be imprinted by a final pass along the project perimeter. If conditions do not permit imprinting the perimeter, a turn-around area within the project need not be fully imprinted.
3. Any un-imprinted turn-around area on the project boundary shall be no wider than the smallest turning radius allowed by the equipment.

F. Timing

1. The date of imprinting shall fall shortly before or within the early portion of the annual rainy season, November - December.
2. Where the annual rainfall has a bimodal distribution, imprinting shall be carried out during the winter rainy season.

G. Seed distribution

1. Seed dispensed by the imprinting device shall be in firm contact with the soil.
2. A minimum of 150 live seeds per square meter shall be planted.
3. The seed bin shall contain no residual seed from previous uses.
4. Wheat bran or approved substitute shall be mixed with seed to appropriate dilution ratio to prevent seed segregation. The optimum-mixing ratio is usually 1:1 by volume.

H. Mycorrhizal inoculation

1. Mycorrhizal inoculum shall be added to the seed bin of the land imprinting equipment and mixed into the seeds and such other materials as wheat bran. Mycorrhizal inoculum must not be placed in any equipment that has heated up in the sun to a temperature higher than 90° F.
 - a. At no time during storage or application shall inoculum be exposed to temperatures above 90 degrees or below 32 degrees F.
 - b. The inoculum dispensing mechanism shall not be allowed to heat in the sun to temperatures above 90 degrees F.
2. If the land imprinter is equipped with a separate bin for mycorrhizal inoculum, the inoculum shall be dispensed from the separate bin in accordance with the operating procedures for the specified imprinter.
3. The application mechanism shall grind or macerate not more than 5% of the particles or granules in the inoculum.
 - a. Root material shall be removed from the inoculum only if the material will not otherwise pass through the application mechanism.
4. Mycorrhizal inoculum shall be deposited in front of the imprinting roller and beneath the soil surface, with seventy per cent or more of the inoculum deposited between one and six inches beneath the final soil surface.
5. The inoculum injection device shall inflict minimal damage upon the soil. Devices that form narrow slits in the soil are preferred to ripping, disking, or tilling.

1.24 GERMINATION

- A. It shall be the responsibility of the Contractor to operate and manage the irrigation system to achieve proper germination of the seed after application. Refer to Irrigation and Maintenance specifications elsewhere.

1.25 RESEEDING

- A. The Contractor shall reseed bare spots failing to adequately germinate an adequate number of plants within 10 days.
 - 1. The Architect shall be the sole judge of adequacy of coverage.
 - 2. The Contractor shall remain responsible for reseeding until the Architect approves seed application and germination.

1.26 CLEANUP

- A. After all seeding operations have been completed, remove all trash, empty containers and rubbish from the property and dispose of legally. All scars, ruts, or other marks in the ground caused by this work shall be repaired and the ground left in a smooth condition throughout the site. The Contractor shall sweep the site and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition.

END OF SECTION

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DIVISION 33

UTILITIES

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SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Requirements: Provide water distribution system, complete, as indicated on the Drawings or inferable therefrom and/or as specified in accordance with the Contract Documents.

1.02 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's specifications and installation instructions for each material. Include certification or other data verifying compliance with required characteristics. Indicate by transmittal form that copy of each has been distributed to the Installer.
- B. Test Reports: Submit certified Test Reports showing compliance of the following items in accordance with Section General Conditions.
 - 1. Laboratory test for bedding and trench stabilization materials.
 - 2. Concrete design mix.
 - 3. Compression tests.
 - 4. Water Test Reports: Submit results of water sample tests by State or local health authorities

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
 - 3. The Contractor shall have one copy of the Standard Specifications at the job site.
 - 4. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- E. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping.

2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.04 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify Owner's Representative not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Owner's Representative written permission.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prevent damage to materials during loading, transportation, and unloading. Store equipment with moving parts off ground on platforms or skids.

1.06 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PIPE AND FITTINGS

- A. PVC, Schedule 40 (NPS 1/8 to NPS 3 1/2): ASTM D 1785. Suitable for potable water distribution and manufactured in compliance with NSF Standards.
 1. Fittings: PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 DR 14, with bell-and-spigot or double-bell ends.
 1. PVC to PVC Fittings: Push-on-Joint, PVC Fittings, ASTM 3139, with elastomeric gasket bell ends, conforming to ASTM D2122 for bell measurements.
 2. PVC to Metal Fittings, Valves, and Accessories: Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Use corrosion resistant, high strength, low alloy steel, bolts and nuts where in contact with corrosive soil ASTM A 325.

2.03 VALVES

A. AWWA, UL/FM Cast-Iron, Gate Valves:

1. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509 and UL/F.M. approved, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - a. Minimum Working Pressure: 200 pounds per square inch gauge (psig).
 - b. End Connections: Flanged, push-on rubber gasketed, or mechanical joint, as required.
 - c. Interior Coating: Complying with AWWA C550.
2. Campus Specific Manufacturers
 - a. Harbor: Reliable
 - b. Trade: Reliable, TYCO, or NIBCO

2.04 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately five-inch diameter barrel. Fabricate valve box cover to fit snugly to prevent displacement by traffic.

1. Operating Wrenches: Steel tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Vertical-Type Indicator Posts: UL 789, FM-approved, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve with tamperproof electrical supervisory switch for connection to the fire alarm control panel system.

1. Campus specific Manufacturers:
 - a. Harbor: Clow or Mueller
 - b. Trade: Clow or Mueller

2.05 VALVE APPLICATION

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

1. Where specific valve types are not indicated, the following requirements apply:
 - a. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated, gate valves with valve box.
 - b. Underground Valves, NPS 4 and Larger, for Vertical-Type Indicator Posts: UL/FM, Cast-iron, nonrising-stem gate valves with indicator post.

2.06 CORROSION-PROTECTION ENCASUREMENT FOR PIPING

A. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWAA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.

2.07 WATER METERS

- A. Water meter(s) indicated on drawings shall be installed by the local water purveyor for the area, unless noted otherwise.
- B. For sub-meter specification, refer to Plumbing Design Standard, Section 22 00 00.

2.08 BACKFLOW-PREVENTION DEVICES

- A. General: FM Approved, AWWA, UL Classified, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.
 - 1. Working Pressure: 175 pounds per square inch (psi) minimum, unless otherwise indicated.
 - 2. Interior Components: Corrosion-resistant materials.
 - 3. Exterior Components: Assembly shall be provided with flanged connections, galvanized cast-iron or epoxy coated construction.
- B. The domestic water system shall be provided with reduced pressure backflow preventers. As a minimum, each building shall be provided with one backflow preventer.
- C. Reduced-Pressure-Detector Assembly Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks; pressure-differential relief valve with ASME A112.1.2, air-gap fitting located between two positive-seating check valves; and bypass with displacement-type water meter, valves, and reduced-pressure backflow preventer. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.
- D. Double-Check-Detector Assembly Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks; two positive-seating check valves; and bypass with displacement-type water meter, valves, and double-check backflow preventer. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.
- E. Campus Specific Manufacturers
 - 1. City: Febco, Watts, or Wilkins
 - 2. East: Watts, Zurn, or Wilkins
 - 3. Harbor: Watts, Febco, Zurn, or Wilkins
 - 4. Mission: Watts or Conbraco
 - 5. Pierce: Wilkins, Febco, watts, or Zurn
 - 6. Southwest: Watts, Zurn, or Wilkins
 - 7. Trade: Wilkins or Febco
 - 8. Valley: Watts, Wilkins, or Febco
 - 9. West: Wilkins, Febco, or Watts

2.09 FIRE HYDRANTS

- A. Before procurement, verify approval has been issued by the Fire Department having jurisdiction.
- B. Wet-Barrel Fire Hydrants: AWWA C503 or UL 312, one NPS 4 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have 150 pounds per square inch gauge (psig) minimum working-pressure design.

1. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
 2. Operating and Cap Nuts: Pentagon, one-and-one-half inches point to flat.
 3. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
- C. Combined length of bury and extension shall be as indicated. Where not indicated, install top of hydrant flange three inches above finished surface.
- D. Exterior Finish: "O.S.H.A. safety yellow" Ameritone 719 or approved equal after receiving a prime coat.
- E. Campus Specific Manufacturers:
1. City: James Jones or Clow Valve
 2. East: James Jones or equivalent
 3. Harbor: Clow Valve, Rich Valve, or James Jones
 4. Mission: James Jones
 5. Pierce: Clow Valve, James Jones, or Rich Valve
 6. Southwest: James Jones or equivalent
 7. Trade: Clow Valve, or Rich valve
 8. Valley: James Jones, Clow Valve, or Rich Valve
 9. West: James Jones or Clow Valve

2.10 FIRE DEPARTMENT CONNECTIONS

- A. Exposed, Freestanding, Fire Department Connections: UL 405, cast-bronze body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate, and all appropriate check valves per NFPA 24.
1. For Escutcheon Plate Marking, refer to plans.
- B. For wall-mounted Fire Department Connections, refer to Section 21 11 19.
- C. Campus Specific Manufacturers:
1. Harbor: Potter-Roemer or Crocker
 2. Trade: Potter-Roemer, Crocker, or Elkhart

PART 3 EXECUTION

3.01 INSPECTION

- A. Examination: Examine substrates, adjoining construction and conditions under which Work is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Field Measurements: Verify dimensions before proceeding with Work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for accuracy of such measurements and precise fitting and assembly of finished work.

3.03 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 3. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.
 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.04 PIPING INSTALLATION

- A. Project site water lines shall terminate approximately five feet from buildings, unless otherwise indicated on Drawings. Install temporary cap or plug terminals for future connection to building.
- B. Unless otherwise indicated, install all piping, including shutoff valves and strainers, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- C. Bury domestic water piping with depth of cover over top at least 36 inches, unless otherwise indicated.
- D. Underground fire protection service piping shall have at least 3 feet of cover, or as recommended by NFPA 24, whichever is greater.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
- F. Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports for all lines NPS 3 or greater.
- H. Make changes in direction of pipes only with fittings or pipe bends and changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- I. Water Main Connection: Arrange and pay for tap in the water main, water meter, and all associated fees from the water purveyor.

3.05 CLEARANCE OF WATER LINE

- A. Building or Structure: Two feet minimum horizontal separation.
- B. Sewer crossing:
 1. Typical Conditions: Lay water mains over sanitary sewers to provide vertical separation minimum three feet.

2. Unusual Conditions: If above separation cannot be met, for sewers less than three feet below the water pipe, use the following:
 - a. Install water line with all joints located at least four feet from each side of the sewer pipe.
 - b. Sewer pipe encased in six inches concrete around pipe, and extend four feet either side of water main.
- C. Parallel to Sewer Line: Water line shall not be installed in a common trench with the building sanitary sewer unless both of the following requirements are met:
 1. The bottom of the water pipe, at all points, shall be at least 12 inches above the top of the sewer.
 2. The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a minimum clear horizontal distance of at least 12 inches from the sewer.

3.06 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches for all lines NPS 3 or greater. Include anchorages for the following piping systems:
 1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 2. Fire-Service-Main Piping: According to NFPA 24.
 3. If soils are corrosive, per the geotechnical report, apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.07 VALVE INSTALLATION

- A. Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box. Vertical-Type Indicator Post Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.
 1. Manufacturers: NIBCO, Acorn, Zurn, or equivalent.
- B. Unless otherwise indicated, install all piping, including shutoff valves and strainers, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.

3.08 BACKFLOW-PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers with relief drain in vault or other space subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support three-inch and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.
- E. Access and clearance shall be provided for the required testing, maintenance and repair. Access and clearance shall require a minimum of one foot between the lowest portion of the assembly and grade or platform.

- F. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.
- G. Domestic water and irrigation backflow prevention devices shall be on a concrete pad with a lockable cage. The cage shall have a rounded top to reduce the likelihood of a student sitting on the top of the cage. The cage shall be of suitable construction to prevent damage due to students sitting on it.
- H. Install unit in accordance with LADWP Rule 16-D, between 12" and 48" above the finish grade, unless noted otherwise.

3.09 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. UL/FM-Type Fire Hydrants: Comply with NFPA 24.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections of types and features indicated.
- B. Install ball drip valves at each check valve for fire department connection to mains.

3.11 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. Refer to Section 22 00 00 Plumbing System Design Criteria, Section 1.1.L for tracer wire specifications.

3.12 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than 150 pounds per square inch (psi). Examine all exposed pipe, joints, fittings and accessories during the test period. Replace or repair defective portions of the system, and repeat tests until results are satisfactory.
 - 1. Allowable leakage shall be as specified in AWWA C-600, Table 3.
- C. Prepare reports of testing activities.

3.13 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:

- a. Fill system or part of system with water/chlorine solution containing at least 50 parts per million (ppm) of chlorine; isolate and allow to stand for 24 hours, or
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 parts per million (ppm) of chlorine; isolate and allow to stand for three hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION

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SECTION 33 31 00

SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
 - 1. Cleanouts.
 - 2. Precast concrete manholes.

1.02 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.03 SUBMITTALS

- A. Manufacturer's product data for pipe and fittings.
- B. Field quality-control test reports.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
- B. For Campus specific requirements, refer to the latest version of the "Composite LACCD Campus Standards Matrix"

2.02 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.03 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.04 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 1. Diameter: Forty-eight inches, unless otherwise indicated.
 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 3. Base Section: Six-inch minimum thickness for floor slab and four-inch (100-mm) minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
 4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
 8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
 9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
 10. Grade Rings: Reinforced concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
 11. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording "SANITARY SEWER."
 - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

2.05 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 1. Top-Loading Classification: Heavy duty.

2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.06 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 3,250 pounds per square inch (psi) minimum unless otherwise noted, Aggregate Gradation "C" per SSPWC 201-1.3.2 and 0.45 maximum water/cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: Two percent through manhole unless otherwise noted.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: Four percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.07 CORROSION-PROTECTION ENCASUREMENT FOR PIPING

- A. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWWA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Shielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.02 PIPING INSTALLATION

- A. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- B. All sanitary piping shall have at least 36" of cover when leaving the building.
- C. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow, at minimum slope of one percent, unless otherwise indicated.
 2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.03 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
 2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.04 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

3.05 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 pounds per square inch (psi).

3.06 FIELD QUALITY CONTROL

- A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Allowable leakage is maximum of 50 gallons/inch of nominal pipe size per mile of pipe, during 24-hour period.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 pounds per square inch gauge (psig).
 - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B. Leaks and loss in test pressure constitute defects that must be repaired.
- C. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION

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SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage pipe and drainage structures outside the building.

1.02 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.
- B. Storm drainage piping system will be sized in accordance with two (2) inches per hour of rainfall intensity.

1.03 SUBMITTALS

- A. Product Data: For each type of product installed.
- B. Field quality-control test reports.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
- B. For Campus specific requirements, refer to the latest version of the "Composite LACCD Campus Standards Matrix."

2.02 CORRUGATED HIGH DENSITY POLYETHYLENE (HDPE) HDPE PIPE AND FITTINGS

- A. HDPE Drainage Pipe and Fittings, NPS 4 to NPS 10: AASHTO M252, Type S, with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastomeric seals.
- B. HDPE Drainage Pipe and Fittings, NPS 12 to NPS 60: AASHTO M294, Type S, or ASTM F2306 with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastomeric seal.

2.03 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

- B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.04 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.05 PUMPED PIPING

- A. For pump discharge below ground and outside of building, refer to Facility Storm and Sanitary Pipe and Fittings, Section 22 13 00.

2.06 CLEANOUTS

- A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.07 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 1. Diameter: Forty-eight inches minimum, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 3. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 - 4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
 - 5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 6. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
 - 7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording "STORM DRAIN."
 - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48, Class 35 gray iron, unless otherwise indicated.

2.08 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
 5. Pipe Collars, Ballast and Pipe Supports, Precast Manhole Components, Catch Basins, and Sidewalk Culverts: Portland cement design mix, 3,250 pounds per square inch (psi) minimum unless otherwise noted, Aggregate Gradation "C" per SSPWC 201-1.3.2, and with 0.45 maximum water-cementitious materials ratio.
 - a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - b. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.09 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 1. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
 2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
 3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- B. Frames and Grates:
 1. ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (heavy traffic) structural loading unless otherwise indicated in plans.
 2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.
 3. Compliant with Americans with Disabilities Act (ADA).
 4. Heelproof as indicated per plans.
 5. Grate size as indicated per plans.

2.10 CORROSION-PROTECTION ENCASEMENT FOR PIPING

- A. All metallic underground piping shall be encased in a Polyethylene tube or wrapped in a Polyethylene sheet. The Polyethylene shall conform to ASTM A674 or AWWA C105, high density, cross laminated, having a thickness of 0.004 inch or LLDPE having a thickness of 0.008 inches.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Shielded flexible couplings for same or minor difference OD pipes.
 - b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.02 PIPING INSTALLATION

- A. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- B. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections unless direct tap into existing storm drain is indicated.
- C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of one percent, unless otherwise indicated.
 - 2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- E. Clear interior of piping and manholes of dirt and superfluous material as work progresses.
- F. Overflow discharges shall not be onto public walkway but rather through a fitting that takes the line under a walkway and discharges through a curb.

3.03 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
 - 2. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.04 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

3.05 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.
- B. Provide storm drain piping connections to catch basins as indicated in the project drawings. Storm drain connections shall be to the catch basin side wall, not base.

3.06 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 pounds per square inch (psi).

3.07 LOW IMPACT DEVELOPMENT STORM WATER MITIGATION SYSTEMS INSTALLATION

- A. All storm water mitigation systems proposed as a part of this project, and as approved by the local jurisdiction, are to be inspected by the Civil Engineer of Record during the installation process, after installation is complete, and prior to obtaining a certificate of occupancy.
 - 1. Notify the Civil Engineer of Record at least 24-48 hours prior to the following (minimum) stages, in addition to those noted above, for inspection purposes:
 - a. Excavation for system installation.
- B. Placement of gravel fills, system liners, piping, inlet and overflow piping, soil backfill, and planting where required.

3.08 FIELD QUALITY CONTROL

- A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sewers according to requirements of authorities having jurisdiction and the following:
 - a. Allowable leakage is maximum of 50 gallons/inch of nominal pipe size per mile of pipe, during 24-hour period.
 - b. Close openings in system and fill with water.

- c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 pounds per square inch gauge (psig).
 7. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B. Leaks and loss in test pressure constitute defects that must be repaired.
- C. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 33 47 00
BIOFILTRATION SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies materials and procedures for construction of biofiltration systems that are complete and ready for operation. This includes excavating existing soils, removing irrigation piping, installing perimeter geomembrane liner, aggregate base, biofiltration media, mulch, underdrains, outlet structure, piping, and all other incidentals.
- B. Other items of work or details not mentioned above that are required by the Plans or these Special Provisions, shall be performed, placed, and constructed.
- C. Existing utilities shall be protected in place, unless noted otherwise.

1.02 RELATED WORK

- A. Section 31 10 00, SITE CLEARING
- B. Section 31 22 00, GRADING
- C. Section 31 23 23, EXCAVATION AND FILL FOR UTILITIES
- D. Section 32 01 90, LANDSCAPING: Planting Preparation, Plants, Planting Accessories.
- E. Section 32 84 00, LANDSCAPE IRRIGATION SYSTEM: Piping, Sprinklers, Controllers, and Accessories.
- F. Section 33 40 00, STORM DRAIN UTILITIES: Piping, Structures.

1.03 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
 - 1. American Society for Testing and Materials (ASTM):
 - 2. D422 Standard Test Method for Particle-Size Analysis of Soils
 - 3. D698 Standard Test Method for Laboratory Characteristics of Soil Using Standard Effort
 - 4. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
 - B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. 200-2 Untreated Base Materials
 - 2. 301-2 Untreated Base

1.04 SUBMITTALS

- A. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 33 47 00, BIOFILTRATION SYSTEMS", with applicable paragraph (subsection) identification and proposed use.
- B. Perimeter Geomembrane Liner
 - 1. Submit copies of the manufacturer's specifications including placement specifications.
- C. Biofiltration Media
 - 1. The supplier shall verify in writing, and provide lab analyses that the material complies with the processes, testing, and standards on the Plans or these Special Provisions. An independent STA Program certified laboratory shall perform the analysis.
 - 2. A list of the feedstock by percentage present in the final compost product.
 - 3. A copy of the producer's STA certification as issued by the U.S. Composting Council.
 - 4. Acceptance will be based upon a satisfactory Test Report from an independent STA program certified laboratory.
- D. Permeable Aggregate Base
 - 1. The supplier shall verify in writing and provide laboratory analyses from an independent laboratory that the permeable aggregate base complies with the processes, testing, and standards on the Plans or these Special Provisions.
- E. Mulch
 - 1. Submit two (2) product sample, specification, and source.

1.05 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. When two or more units of the same type or class of materials are required, these units shall be products of one manufacturer.
 - 2. Manufacturer's data including:
 - a. Geomembrane Liner (Data sheet; installation literature; certificate of conformance)
 - b. Geotextile Fabric (Data sheet; installation literature; certificate of conformance)

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not store PVC pipe and fittings in direct sunlight.
- B. Geotextiles shall be furnished in rolls wrapped with a protective covering to protect it against ultraviolet radiation and abrasion. Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width, and production identification number. All filter fabric exposed to ultraviolet radiation (the sunlight) for more than three days shall be rejected by the Engineer and replaced with new filter fabric.

1.07 COORDINATION

- A. Coordinate connection to existing storm sewer main with the District's Representative.

1.08 WARRANTY

- A. Guaranty: Warranty of Construction. Refer to Section O1 78 70 for additional requirements.
- B. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from Substantial Completion. Further, the Contractor will furnish all manufacturers' and suppliers' written guarantees and warranties covering materials and equipment furnished under this Contract.

1.09 AS-BUILT DOCUMENTATION

- A. The installing contractor shall maintain as-built drawings for verification. As-built drawings are to be provided, and a copy of them in Auto-CAD Version 2018, or newer, provided on a flash drive. Refer to Section O1 78 39 for further clarification.

PART 2 PRODUCTS

2.01 PERIMETER GEOMEMBRANE LINER

- A. The impermeable liner shall consist of flexible reinforced or unreinforced tri-polymer gasoline resistant membrane material consisting of polyvinyl chloride (PVC), ethylene interpolymer alloy, and polyurethane or a comparable polymer combination. The geomembrane shall be sufficiently flexible to cover and closely conform to 90 degree edges and corners of the filter bed excavation at ambient temperatures as low as 45°F without application of heat.
- B. Geomembrane shall have the following properties, specified as minimum or maximum, not average roll properties:

Physical Property	Test Reference	Acceptance Value
Thickness (Lowest Individual Reading)	ASTM D5199	36 mil
Density	ASTMD1505	0.940 g/cm ³
Strength at Break	ASTM D6692, Type IV	152 lb/in-width
Strength at Yield	ASTM D6692, Type IV	84 lb/in-width
Physical Property	Test Reference	Acceptance Value
Elongation at Break	ASTM D6692, Type IV	700%
Elongation at Yield	ASTM D6692, Type IV	12%
Tear Resistance	ASTMD1004	28 lbs
Puncture Resistance	ASTMD4833	72 lbs
Carbon Black Content	ASTM D4218	2.0-3.0 %
Notch Constant Tensile Load	ASTMD5397	300 hr
Oxidative Induction Time	ASTM 3895	>100min (200 deg.C, 1atm)

- C. All factory-produced seams shall have a minimum bonded width of 1 ¼ inches, and shall have a minimum shear strength of 320 pounds when tested in accordance with ASTM D 751 (Modified per NSF Standard No. 54).

2.02 BIOFILTRATION MEDIA

- A. Biofiltration Media shall consist of 20% Compost and 80% Sand by volume. The mixture shall be well blended to produce a homogeneous mix, where the final mix to be approved by the Engineer based on samples and test results submitted.
- B. Sand
1. Sand should be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic. Sand for Biofiltration Basin should be analyzed by an accredited lab using #200, #100, #40, #30, #16, #8, #4, and 3/8 sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation (Note: all sands complying with ASTM C33 for fine aggregate comply with the gradation requirements below):
 - 2.

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
3/8 inch	100	100
#4	90	100
#8	70	100
#16	40	95
#30	15	70
#40	5	55
#100	0	15
#200	0	5

C. Compost

1. Compost should be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes, or other organic materials not including manure or biosolids meeting standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA). Compost quality should be verified via a lab analysis to be:
 - a. Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
 - b. Organic matter: 35-75% dry weight basis.
 - c. Carbon and Nitrogen Ratio: $15:1 < C:N < 25:1$
 - d. Maturity/Stability: shall have dark brown color and a soil- like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120 F) upon delivery or rewetting is not acceptable.
 - e. Toxicity: any one of the following measures is sufficient to indicate non-toxicity:
 - 1) $NH_4:NH_3 < 3$
 - 2) Ammonium < 500 ppm, dry weight basis
 - 3) Seed Germination > 80% of control
 - 4) Plant trials > 80% of control
 - f. Solvita® > 5 index value
 - g. Nutrient content:
 - 1) Total Nitrogen content 0.9% or above preferred
 - 2) Total Boron should be <80 ppm, soluble boron < 2.5 ppm Salinity: < 6.0 mmhos/cm pH between 6.5 and 8 (may vary with plant palette) Compost for Biofiltration Basin should be analyzed by an accredited lab using #200, ¼ inch, ½ inch, and 1 inch sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation:

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
1 inch	99	100
½ inch	90	100
¼ inch	40	90
#200	2	10

2.03 MULCH

- A. Three-inch (3") thick layer of mulch shall be well-aged compost that has been stockpiled or stored for at least twelve (12) months. Mulch shall be non-floatable, pass a 3/8-inch screen, prevent clogging of campus storm drain infrastructure.
- B. Mulch shall not contain any biosolids or manure.

2.04 PERMEABLE AGGREGATE BASE

- A. Permeable Aggregate Base beneath Biofiltration Media shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious matter. Washing shall be conducted off-site in a manner that does not cause or contribute to water pollution.
- B. The amount of deleterious substances shall not exceed the following values:
 1. Amount finer than No. 200: 1.00 percent by weight
 2. Pieces of specific gravity less than 1.95: 2.00 percent by weight
 3. Clay lumps: 0.5 percent by weight
 4. Wood waste: 0.05 percent by weight
 - 5.
 - 6.
 - 7.

- C. Permeable Base Grading requirements (ASTM D448, Size No. 57):

Sieve Size	Percent Passing
1-1/2 in.	100
1 in.	95-100
½ in.	25-60
No. 4	0-10
No. 8	0-5

2.05 GROUTED RIPRAP PAD

- A. Caltrans No. 3 Backing Rip Rap Class

- B. Local surface irregularities of the slope protection shall not vary from the proposed finished grade by more than two inches measured at right angles to the slope. Broken concrete, asphalt pavement, and other non-rock materials shall not be used as riprap. Rocks shall be of such shape as to form a stable protection structure of the required section. Flat or needle shapes will not be accepted unless thickness of the individual pieces is greater than 1/3 the length.
- C. Apply Special Provision 03 30 00 CAST-IN-PLACE CONCRETE. Use the 1- inch-maximum combined aggregate gradation in the concrete. The water content of the concrete must allow gravity flow into the interstices with limited spading and brooming.

2.06 PERFORATED UNDERDRAIN

- A. 4-inch polyvinyl chloride (PVC) SDR 35 with drilled or punched perforations as indicated on the Plans. The perforations may be located either in the inside crests or in the flat tangent portion of the corrugations, but not in both locations in the same length of pipe.

PART 3 EXECUTION

3.01 GENERAL

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the District.

3.02 BASIN EXCAVATION

- A. Basin excavation shall comply with Special Provision 31 22 00 GRADING and Section 31 23 23 EXCAVATION AND FILL FOR UTILITIES, as well as the recommendations defined in the Report of Geotechnical Investigation provided under Appendix A.

3.03 PLACEMENT OF PERIMETER GEOMEMBRANE LINER

- A. Impermeable geomembrane shall be placed around the vertical perimeter of the excavation as indicated on the Plans. **No geomembrane liner shall be installed at the bottom surface of excavation or in any horizontal configuration.** Field seams for geomembrane shall have an overlap of 12 inches minimum and bonded with an electrically-heated hot-wedge device as recommended by the manufacturer. Hot air extrusion welding devices or solvent bonding chemicals shall not be used. The bonded geomembrane shall not exceed 165°F immediately before contacting the filter bed excavation.
- B. Before installation of geomembrane, the CONTRACTOR shall demonstrate to the Engineer that the equipment, techniques, and personnel proposed for the bonding of field seams can produce vapor-tight seams under similar weather and work conditions near the job site.
- C. Field seams shall be inspected and, when ordered by the Engineer, shall be tested and pass the Vacuum Box Test. Proper compaction is required to ensure stability and support of the liner. Slopes shall be hand-raked to achieve proper smoothness. To secure the edge of the liner in an earthen pit, an anchor trench shall be provided per Plans. No pins shall be used.

3.04 LAYOUT OF UNDERDRAIN PIPES

- A. Layout and install 4" perforated PVC pipe with 0.5% minimum slope. At least 0.5 feet of permeable aggregate base must be placed to the bottom and to the sides of the underdrain pipe(s). At least 2" of permeable aggregate base must be placed to the top of the underdrain pipe(s).
- B. Use 4" PVC pipe elbows at transitions beneath the proposed drop structures. The role of PVC elbows is to maintain a minimum 12-inch cover of aggregate on top of the underdrain 4-inch perforated PVC pipe.

3.05 PLACEMENT OF BIOFILTRATION MEDIA

- A. Biofiltration Media shall be installed in the Biofiltration Systems per Plan. Filter Bed shall be placed in loose lifts not exceeding 6 inches and compact to a relative compaction of 85 percent of Modified maximum dry density (ASTM D1557), where slopes allow, as determined by the ENGINEER.
- B. Installed Filter Bed should achieve a long-term, in-place saturated hydraulic conductivity of at least 5 inches per hour. Higher infiltration rates of up to 12 inches per hour are permissible. Filter Bed shall retain sufficient moisture to support vigorous plant growth. Three infiltration rate tests shall be performed per basin using an apparatus with minimum diameter of 12 inches (ASTM D5126). Duplicate analyses shall be performed for each batch of media prepared and both tests shall pass this criterion. Placement of Filter Bed prior to receipt of testing results shall be at the CONTRACTOR's risk.
- C. Upon completion of Biofiltration Media placement and compaction and prior to planting and placement of mulch, three in-situ tests of media filtration rate shall be conducted, with observation of the ENGINEER, based on the following protocol:
 - 1. Use a 3-ft long, 12" diameter plastic pipe for testing. Drive pipe approximately 12 inches into BIOFILTER MEDIA layer. If media was loosened during this step, provide light compaction of the soil within pipe to resettle media and ensure short circuiting does not occur along pipe walls.
 - 2. Mark lines on pipe at 0.5 ft intervals from media surface.
 - 3. Fill pipe with water to 1-ft mark above media surface and allow to percolate; maintain water level above basin bottom for at least 2 hours by topping up pipe as needed.
 - 4. Fill pipe to 1-ft mark and allow to percolate without topping up. Record time required to drop 0.5 feet (in hours).
 - 5. Replicate test until difference in time is less than 5 minutes. Record average of last two tests.
 - 6. Multiply average of last two recorded times (in hours) by 17. This is the spot average in inches per hour.
 - 7. Conduct test at two representative locations across each basin.
 - 8. The average of the average values at the three locations shall be between 6 and 10 in/hr and no spot average value shall be less than 4 in/hr or greater than 12 in/hr unless approved by Engineer.
 - 9. Upon completion of tests at each testing location, remove pipe and re-compact soil to eliminate perforations caused by the pipe.
- D. Side Slopes matching existing grades shall not exceed 3H:1V.

3.06 MULCH INSTALLATION

- A. Provide and place new mulch three inches (3") deep over the new Biofiltration Media in the system bottom.

3.07 GROUTED RIPRAP PAD PLACEMENT

- A. Place riprap material to lines and grades as shown on the Plans. Local surface irregularities of the slope protection shall not vary from the proposed finished grade by more than three inches measured at right angles to the slope.
- B. The surface of the rock to be concreted must be cleaned of adhering soil and then moistened. At any one location, place the concrete in a continuous operation during a work day. Deposit concrete by use of chutes, tubes, buckets, pneumatic equipment, or other mechanical methods. Do not allow the concrete to flow more than 2 feet across the rip rap pad.
- C. Immediately after depositing, spade and rod the concrete into place with suitable spades, trowels, or other suitable means. The minimum concrete penetration must exceed a minimum of 10 inches.
- D. After placing the concrete, thoroughly brush the rocks to expose the top surfaces. Outer rocks must project above the concrete by a height of 3" minimum to 4" maximum. After grouting the entire riprap pad, do not allow workmen or loads on the surface for at least 24 hours.
- E. Cure the grouted riprap pads by sprinkling a fine spray of water every 2 hours during the daytime for a period of 3 days.

3.08 PLANTING AND IRRIGATION

- A. Planting and irrigation shall be installed per Section 32 01 90 LANDSCAPING and Section 32 84 00 LANDSCAPE IRRIGATION SYSTEM of these Special Provisions.

3.09 PIPING AND MANHOLE INSTALLATION

- A. Drawing plans and details indicate general location and arrangement of manholes and underground storm drainage piping in the vicinity of biofiltration systems. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Piping and manhole installation shall comply with SSPWC Section 306-7 PREFABRICATED GRAVITY PIPE and per Section 33 40 00 STORM SEWER UTILITIES of these Special Provisions.

3.10 REGRADING

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean, and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. Side Slopes shall not exceed 3H:1V.

3.11 CONNECTIONS TO EXISTING DISTRICT-OWNED MANHOLES AND CATCH BASINS

- A. Make pipe connections and alterations to existing manholes and catch basins so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes and catch basins, including concrete and masonry work, cutting, and shaping.

3.12 CONNECTIONS

- A. Drawing plans and details indicate general location and arrangement of connections in the vicinity of biofiltration basins. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Connections shall comply with the requirements defined in Section 33 40 00 of these Special Provisions.

3.13 FLOOD TESTING

- A. Flood Testing shall be conducted at the conclusion of the 90-day plant grow-in period using the following procedure.
 1. Underdrains shall be plugged at the outlet structure to minimize water consumption during testing.
 2. Prior to testing, broom sweep gutter and other impervious surfaces within the test area to remove sediments and other objectionable materials.
 3. The Engineer/Landscape Architect shall be present during the demonstration. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to testing.
 4. The Contractor shall water test each biofiltration system facility to demonstrate that all inlet curb openings are capturing and diverting all water in the gutter to the facility, outlet structures are engaging at the elevation specified, and the designed ponding depth is achieved. Testing shall include application of water from a hydrant or water truck, at a minimum rate of 10 gallons per minute, into the gutter a minimum of 15 feet upstream of the inlet curb opening being tested. Each inlet shall be tested individually. If erosion occurs during testing, restore soils, plants, and other affected materials.
 5. Engineer/Landscape Architect will identify deficiencies and required corrections, including but not limited to relocating misplaced plants, adjusting streambed gravel, adjusting mulch, adjusting inlets, splash aprons, and forebays, removing and replacing inlets, and removing debris.
 6. Once adjustments are made, the Contractor shall re-test to confirm all test water flows into the facility from the gutter and correct any remaining deficiencies identified by Engineer/Landscape Architect.
 7. Inlets, outlets, and other bioretention facility appurtenances shall not be accepted until testing and any required correction and retesting is complete and accepted by the Engineer/Landscape Architect.
- B. CLEANING
 1. Vacuum any sediment or debris from the biofiltration systems and storm drain system. Sediments and debris shall not be washed out with water.

END OF SECTION

DIVISION 41

MATERIAL PROCESSING AND HANDLING EQUIPMENT

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SECTION 41 34 23

PAINT SPRAY BOOTHS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Spray-Systems [Downdraft] [Cross draft] Spray Booth.
- B. Accessories required to provide a functional and operational spray booth.

1.02 SUBMITTALS

- A. Product Data: Provide unit capacities, physical dimensions, utility requirements and locations, point loads.
- B. Shop Drawings: Show layout and configuration of complete paint booth and suspended maintenance system, including all components and accessories.
 - 1. Clearly indicate design and fabrication details, hardware, rough-in and anchor placement dimensions, tolerances, clearances required and installation details.
- C. Operation Data: Include description of system operation, adjusting and testing required.
- D. Maintenance Data: Identify system maintenance requirements, servicing cycles, lubrication types required and local spare part sources.
- E. Test Reports: Indicate that when products are used in this paint booth, current SCAQMD standards shall not be exceeded.
- F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in College's name and registered with manufacturer.
- G. Maintenance Materials: Furnish the following for College's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Spare Parts: Manufacturer shall certify that he stocks most spare parts for this system with-in 100 miles of the college campus and shall be able to deliver them with-in two working days.

1.03 QUALITY ASSURANCE

- A. Paint Booth be allow for the expected use of the booth to comply with South Coast Air Quality Management District requirements.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
- C. Fabricator Qualifications: Either the manufacturer or certified by the manufacturer.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for operating unit.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of unit.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components to project site in original packaging.
- B. Store components under cover and elevated above grade.

1.06 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.
- B. Provide five year manufacturer warranty for paint booth, (except for filters).

PART 2 PRODUCTS

2.01 PAINT SPRAY BOOTHS SYSTEM

- A. Basis of Design Manufacturer: Determined by project requirements, www.spraysystems.com., or equal.

2.02 COMPONENTS

- A. Booth Size: *(The following is an example only; each project must determine the specific requirements for the individual project)*
 - 1. Inside dimensions: 26 feet 0 inches long by 14 feet 0 inches wide by 9 feet 0 inches high.
 - 2. Outside dimensions: 26 feet 4 inches long by 14 feet 11 inches wide by 10 feet inches high.
- B. Doors: *(The following is an example only; each project must determine the specific requirements for the individual project)*
 - 1. Product Doors:
 - a. One Set of Single Leaf Solid Doors
 - b. Net opening: 8 feet 9 1/2 inches high x 9 feet 2 1/4 inches wide.
 - c. Structural tube frame.
 - d. Continuously welded.
 - e. Leak proof wiper type seals at the base.
 - f. Heavy duty safety latches.
 - 2. Side Access Door
 - a. 2 access door measuring 36 inches x 84 inches with 2 observation window 18 inches x 36 inches, 1/4 inches clear tempered glass
 - b. 2 Observation window 18 inches x 36 inches, 1/4 inches clear tempered glass
 - c. Door safety latch

- C. Lighting *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. 10 Vapor Tight, Class I, Div. II, Inside Access, High Efficiency, 48 inches, 4-Tube, Universal Ballast.
 2. Industrial rated - White Coated Enamel.
 3. UL Approved.
 4. Electronic ballast for energy efficient T-8 tubes.
 5. Universal Sockets.
 6. Rear hinged access panel for easy maintenance.
 7. Set in framed opening with 3/16 inches clear tempered glass, Glass to comply with Section 08 80 00 Glazing.
- D. Exhaust Fan and Motor: *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. One 42 inches Diameter Spray Systems, High Efficiency, Tubeaxial Exhaust Fan.
 2. Non Sparking blade, enclosed belts and bearings.
 3. Rated for 18,200 CFM @.5 inches S.P.
 4. 50 FPM average face velocity through the booth (Empty).
 5. 3 HP, 208-230/460V - 60 Hz - 3 Phase.
- E. Exhaust Filters: *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. 18 American Air Filters, AG28.
 2. 20 inches x 25 inches with holding hardware.
 3. UL Approved
- F. Intake Filters: *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. 16 Viledon, PA560G.
 2. 20 inches x 50 inches with holding hardware.
 3. 95% efficiency rating.
 4. Supply air plenum located on top of booth.
- G. Draft Gauge *(The following is an example only, each project must determine the specific requirements for the individual project)*
1. 2 Dwyer Mark II manometers to indicate replacement of filters.
- H. Undergrate Exhaust Rack: *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. Durable 18 gauge, G90 filter frames and holdings angles.
- I. Inground Grating *(The following is an example only, each project must determine the specific requirements for the individual project)*
1. Welded steel grates, 36 inches x 48 inches.

2. Safe concentrated mid Span load of 900 lbs.
- J. Exhaust Duct Package: *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. Duct package IS NOT included in base price
 2. Meets all Uniform Fire Code Requirements
 3. 42 inches Exhaust Duct Package to includes:
 - a. One lot of Spiral Straight Duct 34 inches diameter.
 - b. One insulated sleeve 34 inches diameter x 4 feet long.
 - c. One Roof jack (flat).
 - d. One Storm collar.
 - e. One Clean out door 12 inches x 16 inches.
 - f. One 34 inches Diameter weather canopy.
 - g. One Motor Cover.
 - h. One Floor Transition.
- K. Make Up Air VRV Vertical unit. *(The following is an example only; each project must determine the specific requirements for the individual project)*
1. Hot Water Coil: 180 DegreeF EWT, 0% Glycol.
 2. 100% Replacement Air.
 3. 20,000 SCFM / 0.5 Duct SP.
 4. Electric Current: 460/60/3, 3-Wire Service.
 5. Outdoor Safety Switch (Disconnect) and Motor Starter.
 6. Unit Location: Outdoor Installation.
 7. 15 HP Motor - Open Drip Proof - High Efficiency EPACKT.
 8. 1,302 BTUH (in 1000's) / 60 Temperature Rise (deg F).
 9. Temperature Control System:
 - a. Discharge Control (J.C. FX14 DDC & Modulating Valve).
 10. External Discharge Damper with 2 Position Motor and Interlock.
 11. V-bank with Two inch Cleanable Filters.
 12. Vertical Mounting Stand.
 13. G90 Galvanized casing.
 14. Remote Control Panel:
 - a. Supply/ Exhaust Motor Circuits Sub-Fused.
 - b. Two Speed Operation via Supply VFD.
 - c. Supply VFD in Unit Vestibule W/Vent Pkg.
 - d. Serpentine Element Coil Freeze thermostat.
 - e. Exhaust VFD - 1 Exhaust Motor @ 5 HP ea.
 - f. Ex. VFD in Unit Vestibule (Single Point Feed).

- g. Exhaust Fan / Motor by Division 23.
- h. Lighting Contactor in Unit Vestibule.
- i. Separate Light Power - Disconnect/Fuses by Division 26.
- j. Unit Disconnect & Fast-acting Fuses for VFD.
- k. ETL Label.

15. Include Supply Duct: From Discharge of AMU to Booth Supply Plenum.

2.03 FABRICATION

- A. 18 gauge G90 galvanized steel.
- B. CNC pre-punched holes on 6 inches centers.
- C. 12 gauge base angle.
- D. Fasteners: Nuts and bolts.

2.04 MISCELLANEOUS

- A. All necessary hardware and caulking is included
- B. Exploded view CAD assembly drawing
- C. Booth components labeled and identified with a computer-generated label to correspond to the exploded CAD view assembly drawing for easy installation.

PART 3 EXECUTION

3.01 INSTALLERS

- A. Coordinate installation with work of other installers.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and UL requirements.
- B. Install equipment in accordance with approved shop drawings.

3.03 ADJUSTING

- A. Adjust and leave equipment in proper working order.
- B. Complete Initial Inspection - Certification for Use form included in Equipment Manual and Inspection Log Book.

END OF SECTION

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